

# *Cleveland Park Citizens Association*

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October 21, 2002

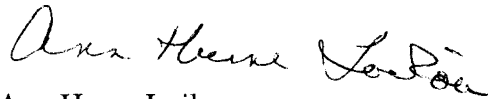
Zoning Commission of the District of Columbia  
c/o Mr. Alberto P. Bastida, AICP  
Secretary to the Zoning Commission  
Office of Zoning  
441 4<sup>th</sup> Street, NW, Suite 210  
Washington, DC 20001

Re: Case No. 01-02 (Text Amendment – Regulation  
of Antennas, Antenna Towers, and Monopoles)

Dear Commissioners:

I would like to submit for the record several scientific studies on the radiation emissions and effects from mobile phone masts (monopoles).

Sincerely,



Ann Hume Loikow  
Second Vice President

**ZONING COMMISSION**  
**District of Columbia**  
Case 01-02  
EXHIBIT 104  
EXHIBIT NO. 104

**PARLIAMENTARY OFFICE FOR EVALUATION OF  
SCIENTIFIC AND TECHNOLOGICAL ALTERNATIVES**

***Hearing of 6 March 2002 at the request of  
Senators Jean-Louis LORRAIN and Daniel RAOUL***

**ARGUMENTS IN FAVOR OF APPLYING THE  
PRECAUTIONARY PRINCIPLE TO COUNTER THE EFFECTS OF  
MOBILE PHONE BASE STATIONS**

**By**

**Roger SANTINI**

Doctor of Science  
Lecturer

**I – INTRODUCTION.**

To allow for the correct functioning of the millions of mobile cellular telephones, thousands of mobile telephone base stations have been sited in Europe and throughout the entire world. In the preponderant digital technology currently on the market, high frequencies (or microwaves - MW) pulsed with extremely low frequencies (ELFs) are utilized. These high frequencies operate in the 900 MegaHertz (MHz) range for the GSM system (Global System for Mobile Communication) and in the 1800 MHz range for the DCS system (Digital Cellular System)<sup>(1)</sup>. Let us note here that these 2 frequency ranges are very close to that of the domestic microwave oven which functions at 2450 MHz.

**Of particular note:**

- The text that follows does not pretend to be exhaustive concerning the numerous scientific studies that report the existence of biological effects relating to exposure to microwaves.
- Neither does it tackle the problem of the biological effects of the extremely low frequencies that are present in mobile telephone signals.

While for the users of mobile cellular telephones the MW exposure is in the “near field”, for the populations living in the vicinity of base stations this exposure is in the “far field”.<sup>(2)</sup>

During the “far field” exposure, different factors are liable to modify the level of exposure for the neighboring populations and in particular:

- The distance from the emitting source: at several meters from a base station, one can measure high frequency power densities of several tens of microwatts per

centimeter squared ( $\mu\text{W}/\text{cm}^2$ ) through  $10\mu\text{W}/\text{cm}^2$  (6.1 volts per meter – V/m) at 50 meters<sup>(3)</sup>.

- The fact of whether or not one falls within the principal high frequency lobe situated in front of emitting antennas: this principal lobe carries electromagnetic energy stronger than that of the secondary lobes found on the sides of and behind the antennas.
- The presence of “passive reflectors” in the form of metallic structures (window shutters, garage doors, flights of stairs, etc.) capable of amplifying high frequencies.<sup>(4)</sup>
- Fluctuations in the strength of the signals emitted by base stations as a function of the number of telephone calls being handled by them.
- The presence of other electromagnetic sources in the environment (power lines, electrical transformers, household electrical equipment, etc.) that can interfere with high frequencies from base stations.<sup>(5)</sup>

Measurement of electromagnetic fields in the environment of base stations at any given moment appears insufficient to accurately describe the level of chronic exposure to high frequency radiation for neighboring inhabitants. One key factor is that the number of antennas present and operating at a given site varies over the course of time according to the needs of different operators.

## **II. WHY SHOULD THE PRECAUTIONARY PRINCIPLE BE APPLIED TO COUNTER THE EFFECTS OF BASE STATIONS?**

Several arguments can be advanced and are developed hereafter:

- Microwave effects have been known and referenced for more than 40 years.
- Exposure to a mobile cellular telephone generates biological effects.
- Biological effects are reported among people living in the vicinity of base stations and TV and radio transmitters.
- Certain countries have already adopted for their populations exposure limits lower than the currently accepted limits (in France).
- Sensitivity to high frequencies is not the same for all.

### **1. Microwave effects are known and have been referenced for more than 40 years.**

Chronic exposure to microwaves is responsible for, among other things, the appearance of “microwave syndrome” and augments the risk of cancer.

1-1) “Microwave syndrome”, also called radiofrequency sickness, has been described since the 1960’s by researchers in Eastern countries<sup>(6)</sup>. One recent publication<sup>(7)</sup> clarifies that this pathology is tied to chronic exposure to pulsed high frequencies, similar to those generated by mobile cellular phone technology.

It is characterized by:

- A debility syndrome (fatigue, irritability, nausea, headaches, anorexia, depression).
- A cardiovascular dysfunction syndrome (bradycardia, tachycardia, hypertension or low blood pressure).
- A brain dysfunction syndrome (drowsiness, insomnia, concentration difficulties). Chronic exposure is also associated with dermatological problems (skin allergies, eczema, psoriasis), changes in blood chemistry, disruption of electroencephalograms and reproduction, effects on sense organs, and tumors.

#### **1-2) Carcinogenic risk:**

- From 1953 to 1976 the personnel of the American Embassy in Moscow were subjected to a chronic irradiation from microwaves at a mean power density of 1 to 2.4 uW/cm<sup>2</sup> (1.9 to 3V/m), with maxima of short durations of 5 to 18 uW/cm<sup>2</sup> (4.3 to 8.2 V/m) and with frequencies varying from 600 MHz to 9.5 GHz. One study of these personnel evidences an increased risk of leukemia and of uterine cancer<sup>(8)</sup>.
- A study of 9,590 Canadian telecommunications workers underscores a significant increase in the number of melanomas when compared to the general population<sup>(9)</sup>.
- A survey conducted by the American army on 880,000 persons exposed to microwaves reports a significant increase in the risk of brain tumors<sup>(10)</sup>.
- The effects of chronic exposure of Polish servicemen to ultra-short waves associated with microwaves (frequencies from 150 to 3,500 MHz) have been studied for 20 years on approximately 120,000 persons. The results obtained show significant increases in the risk of cancers of the blood, esophagus, stomach, colon, skin (melanoma) and brain, for a microwave exposure not exceeding 200 uW/cm<sup>2</sup> (27.4 V/m)<sup>(11)</sup>.

### **2. Exposure to a mobile cellular telephone generates biological effects.**

**2-1)** A Swedish-Norwegian epidemiological study of 11,000 mobile cellular telephone users gives evidence to a relationship between the exposure (number and duration of phone calls) and the increase in complaints such as headaches, fatigue, feeling of warmth on the ear<sup>(12)</sup>, etc.

**2-2)** A French study of mobile phone users reports a significant rise in the frequency of complaints during the phone call such as tingling in the ear, feeling of discomfort, and warmth of the ear. These symptoms relate to duration of the call (> 2 min) and the number of calls per day (>2). This study also gives evidence to a greater sensitivity for women to sleep disturbances when compared to men. For the authors the feeling of warmth of the ear represents an alert that should bring about the termination of the phone call<sup>(13,14,15)</sup>.

**2-3)** Other significant effects were observed during experiments conducted on human volunteers, in particular:

- Disruption of cerebral electrical activity<sup>(16)</sup>.
- Changes in sleep<sup>(17)</sup>.
- Effects on arterial pressure<sup>(18)</sup>.

- Increase in headaches<sup>(19)</sup>, etc.

## **2-4) Cancer risks.**

- **In animals:**

A significant rise in the risk of lymphoma following exposure to a GSM-type signal was observed in mice<sup>(20)</sup>.

- **In man:**

- Several publications find no association between mobile phone usage and the risk of cerebral tumors<sup>(21-22-23)</sup>. To the contrary, one study evidences a significant rise in the risk of cerebral tumor linked to mobile phone usage (Relative risk = 2.6. Confidence interval = 1.02 – 6.71)<sup>(24)</sup>.
- Concerning the eye, one study shows a significant rise (Relative risk = 4.2, Confidence interval = 1.2 – 14.5) in the risk of uveal melanoma in relation to “probable/certain” use of a cellular mobile phone<sup>(25)</sup>.

## **2-5) COMOBIO Report** (Communications Mobiles et Biologie: - Program financed by the Ministries of Research and of Industry).

In rats exposed to GSM-type electromagnetic waves generated by a mobile phone, the COMOBIO Report (Internet site: <http://www.sig.enst.fr/comobio>) underscores:

- Disturbances to the Blood-Brain Barrier (permeability of the intracranial blood vessels) which could be, according to the authors, at the origin of localized inflammatory processes responsible for the development of migraine headaches in susceptible people.
- A rise in the number of astrocytes (brain cells) translating to a inflammation that could be the sign, according to the authors, of neuron injury.
- Modifications in the quantity and/or the affinity for their receptors of essential brain neurotransmitters (GABA, Dopamine, Glutamate).

## **Of particular note:**

- The COMOBIO study results confirm the known microwave effects on the Blood-Brain barrier, neurotransmitters, and cerebral receptors in various animal species<sup>(1)</sup>.
- GABA is the brain's principal inhibitor neurotransmitter. Its decrease is the origin of diseases such as epilepsy. It is equally implicated in neurological diseases such as Parkinson's Disease and Huntington's Disease.
- Variations in the concentration of Dopamine in the brain are responsible for pathologies such as Parkinson's Disease and schizophrenia.
- Glutamate is the brain's principal exciter neurotransmitter. Its increase can lead to mood changes (irritability, aggression, etc.). It is equally involved in neurological diseases like Parkinson's Disease.

## **3. Biological effects are reported by persons living in the vicinity of mobile phone base stations and radio/television transmitters.**

### **3-1) Persons in the vicinity of base stations.**

According to an Australian government report<sup>(26)</sup>, persons exposed in their homes at 200 meters from a base station complain of symptoms that recall those described in radiofrequency sickness: chronic fatigue, multiple allergies, sleep disturbances, and premature menopause.

The only study that currently exists is French and concerns 530 persons living in the vicinity of base stations<sup>(27,28)</sup>. In comparison with the reference group (persons situated at > 300 m or not exposed to base stations), it gives evidence of a significant rise in the frequency of certain complaints at a distance of:

- 100 m for irritability, depressive tendencies, memory loss, concentration difficulties, vertigo.
- 200 m for headaches, sleep disturbances, feelings of discomfort, skin problems
- 300 m for fatigue

### **3-2) Persons living in the vicinity of radio/television transmitters**

Radio/television transmitters generate electromagnetic waves that are essentially ultra short (VHF) and/or high frequencies. Studies concerning these types of transmitters demonstrate biological effects at weak and very weak power densities:

- In mice, after 5 successive generations, exposure to an ultra short-wave transmitter (80 MHz) and a high frequency transmitter (900 MHz) and at a power density of 168 to 1.053 nanoWatts per centimeter squared (nW/cm<sup>2</sup> – 0.8 to 1.98 V/m) brings about a lowering of fertility and a general impairment of the physiological state<sup>(29)</sup>.
- In adults exposed within a radius of 2 km to radio (30 MHz)- and television (1 GHz) transmitters at power densities of 1.3 uW/cm<sup>2</sup> (2.2V/m) for television and 5.7 uW/cm<sup>2</sup> (4.6 V/m) for radio, a significant rise in the risk of leukemia and bladder cancer is observed.<sup>(30)</sup>
- In children exposed within a radius of 12 km to television relay transmitters at ultra short waves (63 to 215 MHz) at power densities from 0.02 to 8 uW/cm<sup>2</sup> (0.07 to 5.4 V/m), a significant rise in cases of leukemia and deaths from leukemia is reported<sup>(31)</sup>.
- In children exposed to ultra short (154 to 162 MHz) waves pulsed at 24.4 Hz from a radio transmitter at power densities of 0.3 to 1.64 uW/cm<sup>2</sup> (1.06 to 7.8 V/m) when compared to children who were not exposed or were living behind the transmitter, these effects were demonstrated:
  - Reduction in memory and attention
  - Reduction in motor function
  - Slowing of reflexes<sup>(32)</sup>.
- A study conducted around a radio transmitter in Rome gives evidence of a significant rise in mortality from leukemia for persons living within a 3.5 km radius (Relative risk = 2.5, Confidence interval = 1.07 to 4.83) and a significant lowering of risk with distance away from the transmitter<sup>(33)</sup>.

### **4. Some countries have already adopted lower exposure limits for their populations than those currently allowed (in France).**

In a 1998 order (decree) Italy adopted an exposure limit of 10  $\mu\text{W}/\text{cm}^2$  (6.1 V/m) in place of 450 and 900  $\mu\text{W}/\text{cm}^2$  (41 and 58 V/m) currently allowed in European regulations for the frequencies of 900 and 1800 MHz respectively<sup>(34)</sup>. In December 2000, The Grand Duchy of Luxembourg adopted an exposure limit of 3 V/m<sup>(35)</sup>. In Austria, the Salzburg Resolution recommends 0.6 V/m<sup>(36)</sup>.

**Of particular note:**

- Mayors of French towns have taken actions to prohibit the siting of mobile phone base stations at distances less than 300 m from residences.
- In Belgium in a decision of March 6, 2000, the National Assembly prohibited the siting of a base station antenna by applying the precautionary principle in making mention of the reasonable question of risk for the health the people living nearby.

**5. Sensitivity to high frequencies is not the same for all.**

In 1995 the French Air Force conducted an epidemiological study in which 30 % of the personnel presented with a non-specific neurovegetative syndrome and 10% presented with authenticated clinical signs. Following this study, the National Institute of Research and Safety (INRS) concluded that: ***“These exists indisputably an individual sensitivity the the effects of radiofrequencies. Undergoing the same exposure, certain individuals can present with clinical disturbances and others not.”***<sup>(37)</sup>

According to the International Radiation Protection Association (IRPA), this individual sensitivity to radiofrequencies would have a genetic basis<sup>(4)</sup>.

Recent results underscore a greater sensitivity in women to electromagnetic waves generated by mobile phones<sup>(14,15)</sup> or by a mobile phone base station<sup>(28)</sup> when compared to men. It is equally apparent that children are more vulnerable than adults due to their developing nervous systems and a more intense absorption of electromagnetic energy by their tissues<sup>(2)</sup>.

### **III – CONCLUSION.**

With regard to the preceding, it is advisable from now on to apply the precautionary principle to counter the effects of mobile phone base stations. Some measures should be put into effect rapidly so as to protect the populations living in the vicinity of base stations. In accordance with the precautionary principle, base stations will not be sited at less than 300 meters from populated places. Antennas will be carefully orientated so that the principal high frequency radiation lobe is not directed toward places (daycare centers, schools, hospitals, and senior citizen centers, etc.) where people are found who are susceptible to being more sensitive to electromagnetic nuisances. This prudent avoidance measure must be applied equally to residential areas reached by microwave beams since certain of their occupants can be “electrosensitive.”

Regular measurement of high frequency power densities must be made at different times of day and various times of the year. In base station environments, those living in the vicinity should not be exposed to an average annual power density above 0.1  $\mu\text{W}/\text{cm}^2$  (0.61 V/m). Zones where residents' exposure to high frequencies is above this

amount should be clearly marked (signs at ground level, signs with a signaling system, etc.)<sup>(1)</sup>

A medical follow-up for base station maintenance workers (blood analyses, baseline EEG's and ECG's) is imperative. No base station work site should be entered until the transmitting equipment has been deactivated. For other categories of workers who work in proximity to base stations (elevator maintenance, ventilation maintenance, etc.) it is advisable to post visible warnings about the biological risks and safe distances to respect in relation to base stations.

New microwave frequencies are being developed for mobile telephones. Those very close to microwave oven frequencies (UMTS system in the 2 to 3 GHz range) will contribute, with the buildout of new telecommunications networks (local radio loops, Hertzian bridges, etc.), to the growth of non-ionizing radiation exposure to populations.

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(English translation)

## **Study of the health of people living in the vicinity of mobile phone base stations: I. Influences of distance and sex \***

**R. Santini \*\*, P. Santini, J.M. Danze, P. Le Ruz, M. Seigne**

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### **Summary**

A survey study using a questionnaire was conducted on 530 people (270 men, 260 women) living or not in the vicinity of cellular phone base stations, on 18 Non Specific Health Symptoms. Comparisons of complaint frequencies (CHI-SQUARE test with Yates correction) in relation to the distance from base stations and sex show significant ( $p < 0.05$ ) increase as compared to people living  $> 300$  m or not exposed to base stations, up through 300 m for tiredness, 200 m for headache, sleep disruption, discomfort, etc., 100 m for irritability, depression, loss of memory, dizziness, libido decrease, etc. Women significantly more often than men ( $p < 0.05$ ) complained of headache, nausea, loss of appetite, sleep disruption, depression, discomfort and visual disruptions. This first study on symptoms experienced by people living in the vicinity of base stations shows that, in view of radioprotection, the of minimal distance of people from cellular phone base stations should not be  $< 300$  m. © 2002 Editions scientifiques et medicales Elsevier SAS

**base station / bioeffects / cellular phone**

### **1. INTRODUCTION**

Chronic exposure to high frequency electromagnetic fields or microwaves brings on bioeffects in man such as headaches, fatigue, and sleep and memory disruptions [1, 2]. These biological effects, associated with others (skin problems, nausea, irritability, etc.) constitute what is known in English as "Non Specific Health Symptoms" (NSHS) that characterize radiofrequency sickness. [3] Cellular mobile phone technology uses hyperfrequencies (frequencies of 900 or 1800 MHz) pulsed with extremely low frequencies (frequencies  $< 300$  Hertz) [4]. Even though the biological effects resulting from mobile phone use are relatively well known and bring to mind those described in radiofrequency sickness [5, 6], to our knowledge no study exists on the health of people living in the vicinity of mobile phone base stations.

We are reporting here the results pertaining to 530 people living in France, in the vicinity or not, of base stations, in relation to the distances from these stations and to the sex of the study participants.

### **2. MATERIALS AND METHODS**

#### **2.1. Questionnaire employed:**

A questionnaire similar to that developed for the study on mobile phone users [6] was sent to people wishing to participate in the study. General questions pertained to age, sex, estimated distance from base stations (less than 10 m, 10 to 50 m, 50 to 100 m, 100 to 200 m, 200 to 300 m, more than 300 m) and their location in relation to the antennas (facing, beside, behind, beneath in the case of antennas placed on rooftops). The exposure conditions were defined by the length of time living in the neighborhood of base stations, (less than 1 year through more than 5 years), the number of days per week and the number of hours per day (less than 1 hour through 16-24 hours per day).

Participants were asked to indicate the presence or not of electrical transformers (at less than 10 m), high or very high tension electric power lines (at less than 100 m) and radio and television transmitters (at less than 4 km). The questionnaire also sought information on computer use (more than 2 hours per day) and portable telephone use (more than 20 minutes per day).

The level of complaints for the studied symptoms was expressed by the study participants using a scale of: 0 = never, 1 = sometimes, 2 = often, 3 = very often. Of 570 questionnaires received, 40 were not used due to lack of information on the distance from the base stations or on the level of the complaints experienced. For the 530 questionnaires studied, 270 came from males (average age  $\pm$  or - variation: 45 years  $\pm$  or - 20) and 260 from females (47 years  $\pm$  or - 19). 18 symptoms referenced in the "NSHS" were the subject of the questionnaire, one of which, premature menopause, concerned only females.

\* The results presented in this study do not involve INSA in Lyon. INSA is the French National Institute of Applied Sciences.

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## 2.2 Analysis of results:

The results obtained, pertaining to the frequency of the complaints experienced (in comparison to complaints at a level of "0"), were analyzed by the CHI-SQUARE test with Yates correction [7] using a program (STATITCF, 19787, France). We present here the results tallying:

- a) The influence of distance for the base stations on the frequency of reported complaints, by comparison with the reference subjects, exposed at >300 m or not exposed (no existing base stations or non-operating base stations).
- b) The influence of sex on the frequency of reported complaints, and this independent of the age of the subjects.

## 3. RESULTS

### 3.1 Influence of distance:

The study subjects are distributed in the following manner: 19.6% are at less than 10 m from base station antennas, 26.2% between 10 and 50 m, 13.8% between 50 and 100 m, 9.6% between 100 and 200 m, 10.1% between 200 and 300 m and 20.7% are at more than 300 m or not exposed (reference group).

In comparison with the reference subject group located at >300 m or not exposed to base stations, the complaints are experienced to a significantly higher degree by the subjects located in the distance zones of <10 m through 300 m from base stations. Certain symptoms are experienced significantly more often ( $p < 0.05$ ) uniquely in the immediate vicinity of base stations (<10 m) and not beyond that: nausea, loss of appetite, visual disruptions, difficulty in moving. Significant differences ( $p < 0.05$ ) are observed up through 100 m from base stations for symptoms such as: irritability, depressive tendencies, difficulties in concentration, loss of memory, dizziness, lowering of libido). In the zone 100 m to 200 m, the symptoms of headaches, sleep disruption, feelings of discomfort, and skin problems are again experienced significantly more often ( $p < 0.05$ ) in comparison with the group of subjects at > 300 m or not exposed. Beyond 200 m, only the symptom of fatigue is reported at a significantly high frequency ( $p < 0.05$ ) (Table I). By contrast, no significant effect is demonstrated in relation to distance for the symptom of premature menopause. A significant lowering of libido is reported for the distances of less than 10 m, 10 to 50 m and 50 to 100 m from base stations. For fatigue and headaches Figures 1 and 2 present the percentages of complaints expressed as a function of distance from base stations.

### 3.2 Influence of sex:

Two symptoms were experienced significantly more often in women ( $p < 0.05$ ) as a function of different distance zones: nausea at a distance of less than 10 m, and headaches at distances of 10-50m, 50-100 m, 100-200 m, and 200-300 m. Men complained significantly more often ( $p < 0.05$ ) than women of decrease in libido at a distance of 50 to 100 m from base stations.

When the men/women comparison is made for subjects exposed at a distance of < 300 m, seven symptoms (headaches, nausea, loss of appetite, sleep disruptions, depressive tendencies, feeling of discomfort, and visual disruptions) are experienced significantly more often in women ( $p < 0.05$ ) (Table II). On the contrary, in the group of subjects living beyond 300 m or not exposed to base stations, no significant difference related to sex appears in the frequency of complaints reported for the different symptoms.

## 4. DISCUSSION

This study gives evidence of the fact that bioeffects are reported by people exposed at up to 300 m from base stations. The significant increase in the frequency of complaints in relation to the reference group (people exposed at > 300 m or not exposed) leads toward the observation found in the Australian governmental report indicating that at 200 m from a base station, some people exposed in their homes are complaining of chronic fatigue and sleep disruption [8].

The number of reported symptoms is higher close to base stations and it decreases with increased distance from them. Some symptoms such as nausea, loss of appetite, visual disturbances, and difficulties in movement are no longer experienced in a significant way beyond 10 m. For symptoms that, like fatigue, headaches, and sleep disruptions, are experienced significantly at considerable distances from base stations, no notable diminishment is observed in the percentages of complaints experienced with increased distance. However, the measurements of electromagnetic fields in the neighborhood of base stations show a reduction in field strength over distance [1,9]. One can expect that human sensitivity to electromagnetic waves is such that increased distance from base stations has no significant effect on certain symptoms up to a distance of 200 to 300 m. It is equally possible that the levels of electromagnetic fields found around base stations would not be the exact representation of the levels of exposure of populations. In fact, different parameters are likely to interfere to modify the levels and in particular fluctuations in emission strengths such as the number of calls handled by the base stations, the reflection of electromagnetic waves, etc. [10].

The results obtained demonstrate the greater sensitivity of women for 7 of the studied NSHS. One earlier study relating to portable phone users demonstrated a greater sensitivity of females to the symptom of sleep disturbance. This sex-related difference is parallel to the particular sensitivity of females to electromagnetic fields [11, 12].

## 5. CONCLUSION

From these results and in applying the precautionary principle, it is advisable that mobile phone base stations not be sited closer than 300 meters to populations and most significantly because exposed people can have different sensitivities related particularly to their sex.

**Table I.** Percentages of complaints reported compared to responses of a level of « 0 », by persons living in the vicinity of base stations as a function of their distance away from a base station.

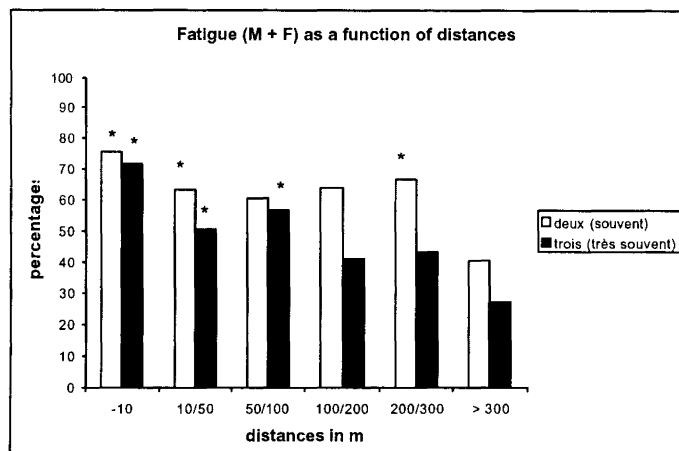
Symptoms	Distances from base stations in meters (m)											
	< 10 m		10 to 50 m		50 to 100 m		100 to 200 m		200 to 300 m		> 300 m ...	
	2	3	2	3	2	3	2	3	2	3	2	3
Fatigue	76 *	72 *	63.5*	50.9*	60.6	56.6*	64.2	41.1	66.6*	43.7	40.7	27.2
Irritability	32.8	23.2*	41.7*	25.7*	47.2*	44.1*	25.8	4.1	25	9	18	3.3
Headaches	51 *	47.8*	40 *	26.1*	40.6*	36.7*	60.7*	31.2*	19.3	0	15.6	1.8
Nausea	14.5*	6.9	8.4	3	5.7	3.8	2.4	4.6	0	2.3	2.1	1.1
Loss of Appetite	20.4*	8.3	8	5.5	5	5	6.9	0	4.2	0	3.3	3.3
Sleep Disruption	41.3*	57.1*	41.4*	57.5*	46.9*	58.5*	45.8*	50*	33.3	35.5	13.8	21.1
Depression	16.9	26.8*	21.6	19.7*	11.6	24 *	16.2	3.1	13.6	2.5	10.3	3.7
Feeling of Discomfort	28 *	45.4*	25.2*	18.9	30.6*	12.8	15.7*	0	9.7	5.1	2.4	8.1
Difficulty in concentration	39.3	28.8*	37.5	16.6	34.2	26.4*	25	12.5	43.3	5.5	26.7	7.1
Memory Loss	27.8	25.4*	29.4	26.6*	37.1*	29 *	25	15.6	17.2	11.1	17.9	5.8
Skin Problems	18.1*	17.1*	6.6	10.8	11.1*	11.1	13.9*	7.5	8.7	0	1.2	4.6
Visual Disruptions	14.5	24.3*	23	13.5	22	7.1	2.5	4.9	15	2.8	13.6	4.1
Hearing Disruptions	33.3*	17.4	17.7*	12	8.3	15.5	7.7	7.7	11.6	9.5	5.6	8.7
Dizziness	10	12.5*	17.3*	7.5*	9.6	9.6*	12.2	2.7	7.7	5.2	6.2	0
Movement Difficulties	5.6	7.7*	8.2	1.7	3	3	0	0	2	0	2.9	1
Cardio-vascular Problems	10.1*	13 *	15.3*	9.6	12.3*	7.4	8.7	0	8.5	6.5	1	3

\* Significant difference ( $p < 0.05$ ) in comparison to reference subjects found at > 300 m or not exposed, for the responses 2 = « often » and 3 = « very often ».

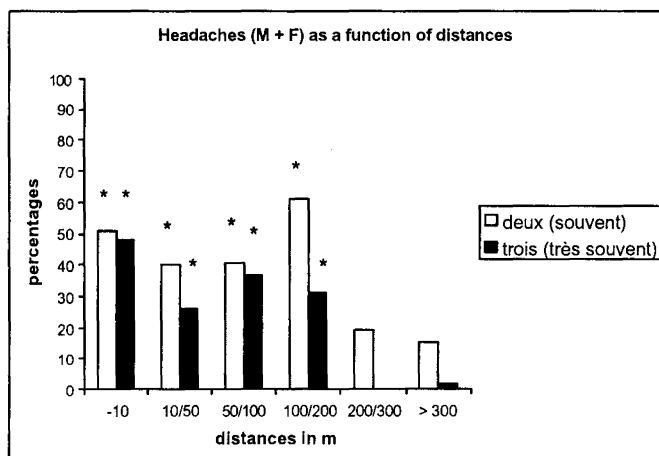
**Table II.** Influence of sex on the frequency of symptoms reported by subjects (205 men, 215 women) living in the vicinity (all distances < 300 m) of mobile phone base stations

Symptoms	Males (%)	Females (%)
Fatigue	41.4	57.5
Irritability	17.9	28.3
Headaches	14.4	45.6 *
Nausea	0	5.9 *
Loss of appetite	1.9	8 *
Sleep disruptions	45.4	61 *
Depressive tendencies	9.8	26.7 *
Feeling of discomfort	15	25.4 *
Difficulties in concentration	18.4	21.6
Memory loss	18	27.7
Skin problems	8	13.1
Visual disruptions	12.2	22 *
Hearing disruptions	9.6	19
Dizziness	6	9.8
Movement difficulties	3.3	2.7
Cardio-vascular problems	8.3	8.8
Lowering of libido	18	12

\*  $p < 0.05$ . Levels of complaints in parentheses.



**Figure 1.-** Frequencies of complaints compared to a response level of « 0 » for the symptom of fatigue, in people living in the vicinity of mobile phone base stations as a function of their distance from base stations.  
M = Males, F = Females, m = meters, deux (souvent) = two (often),  
trois (très souvent) = three (very often).  
\* =  $p < 0.05$  (comparison with the subjects at a distance > 300 m or not exposed).



**Figure 2.** Frequencies of complaints reported in comparison to a response level of « 0 » for the symptom of headaches in people living in the vicinity of base stations as a function of their distance from base stations.  
M = Males, F = Females, m = meters, deux (souvent) = two (often),  
trois (très souvent) = three (very often),  
\* =  $p < 0.05$  (comparison with the subjects at a distance > 300 m or not exposed).

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## **SYMPTOMS EXPERIENCED BY USERS OF DIGITAL CELLULAR PHONES: A STUDY OF A FRENCH ENGINEERING SCHOOL**

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### **ABSTRACT**

A survey study, using a questionnaire, was conducted in 161 students and workers in a French engineering school on symptoms experienced during use of digital cellular phones. A significant increase in concentration difficulties ( $p < .05$ ) was reported by users of 1800-MHz (DCS) cellular phones compared to users of 900-MHz (GSM) cellular phones. In users of cellular phones, women significantly ( $p < .05$ ) complained more often of sleep disturbance than men. The use of both cellular phones and VDT significantly ( $p < .05$ ) increased concentration difficulties. Digital cellular phone users also significantly ( $p < .05$ ) more often complained of discomfort, warmth, and pricking of the ear during phone conversations as a function of calling duration per day and number of calls per day.

*Key Words:* Digital cellular phone; Microwave; Bioeffects; Human

It has been reported that occupational exposures to microwaves produce subjective disorders such as headache, tiredness, sleep disorders, and memory impairment in humans.<sup>1,2</sup> Those symptoms, associated with others (dermographism, tumors, hematological alterations, reproductive, and cardiovascular abnormalities) are known as microwave or radiofrequency sickness<sup>3</sup> and were described first by soviet scientists.<sup>4</sup>

Digital cellular phones emit microwaves pulsed at extremely low frequency.<sup>5</sup> In France, two microwave frequencies are used: 900-MHz for Global System for Mobile Communication (GSM) and 1800-MHz for Digital Cellular System (DCS).<sup>6,7</sup>

Some studies have reported biological effects of electromagnetic fields emitted by cellular phones on working memory: a speeding of response times<sup>8,9</sup> or on events related to brain activity, such as an effect on preparatory slow brain potentials in visual monitoring, or an effect on rapid eye movement during sleep.<sup>11</sup>

Some other studies have reported nonspecific health symptoms (NSHS) during cellular phone use, including headache, dizziness, concentration difficulties, and warmth around the ear.<sup>12-15</sup>

In this paper, we present a study involving 161 human subjects, students, and workers at a French engineering school. This study, using a questionnaire given to users and nonusers of cellular phones, aims to determine the influence of digital cellular phone use on nonspecific health symptoms (NSHS).

## MATERIALS AND METHODS

### Questionnaire Used

A questionnaire was distributed to 161 people at the school. General questions were about: age, sex, model of digital cellular phone used (GSM or DCS), and type of antenna (short, long, incorporated).

Other questions were about use of the cellular phone:

- 1) *Number of calls per day:* <2 calls, 2 to 5 calls, 5 to 10 calls, > 10 calls.
- 2) *Calling duration per day.* <2 mm, 2 to 15 min, 15 to 60 min, >60 min.
- 3) *How long the phone had been owned:* < 3 months, 3 to 9 months, 9 months to 2 years, 2 to 5 years, > 5 years.

A question was asked about the use or nonuse of a video display terminal (VDT). For subjective disorders, questions asked were about:

- 1) **General symptoms experienced by users and nonusers of cellular phone:**  
headache, concentration difficulties, loss of memory, tiredness, or sleep disturbance.
- 2) **Symptoms experienced during cellular phone use:** discomfort, burning sensation of the face, pricking sensation on the ear, or warmth of the ear.

### Informations About Respondents

About 83% of respondents were under 40 years old, 55% were men and 45% were women, 51.5% of respondents had no cellular phone and 48.5% owned a cellular phone.

For users of cellular phones, 70% had a GSM (900 MHz) and 30% had a DCS (1800 MHz) phone. For 95% of users, the number of calls per day was < 5 and for 85% of users, the calling time per day was < 15 min (only 3% of calls were longer than 60 min per day). Eighty-four percent of users owned a cellular phone for <2 years (1% for more than 5 years).

### Data Analysis

Results obtained were analyzed by the Chi-Square test with Yates correction<sup>16</sup> by the way of a VDT program (STATITCF, 1987—France). A  $p < .05$  was considered statistically significant.

## RESULTS

### Comparison of Users vs. Non-users of Cellular Phones

For general symptoms studied (headache, concentration difficulties, loss of memory, tiredness, sleep disturbances), no significant difference was observed in complaint frequencies between users and nonusers of digital cellular phones (Table 1).

### Results for Digital Cellular Phones Users

- 1) *Kind of antenna*: two questionnaires had no response about the antenna. For the 76 responses obtained, 64.4% of cellular phones used had a short antenna, 18.4% a long one, and 17.1% an incorporated antenna. There was no significant difference in general symptoms or in symptoms occurring during communication in relation to the type of antenna (results not shown).
- 2) *Comparison of GSM (900 MHz) vs. DCS (1800 MHz) users*: a significant difference was observed between users of DCS and GSM: more complaints ( $p < .05$ ) were reported for concentration difficulties by DCS users (45.8%) than GSM users (16.6%). No significant difference appeared for other complaints, though headache and tiredness were more often reported by DCS phone users.
- 3) *Incidence of telephone time possession*: for general symptoms and for symptoms experienced during communication, no significant difference was observed between users with cellular phone possession >9 months as compared to users with cellular phone possession < 9 months (results not shown).
- 4) *Sex difference*: women reported significantly more sleep disturbance symptoms ( $p < .05$ ) than men. This sex difference for sleep disturbances was not

**Table 1.** Percentages of Complaints Frequency for Studied Symptoms and for Different Comparisons

Symptoms			900		1800		Cellular Phone	Cellular	Calling	Calling	Number	Number
	Nonusers (83)	Users (78)	MHz (54)	MHz V (24)	wom (27)	Men (51)	Users (28)	Phone+VDT Users (50)	<2 min (22)	>2 min (56)	of Calls <2(50)	of Calls >2 (28)
Headache	7.2	12.8	9.2	20.8	14.8	11.7	3.5	18	18.1	10.7	12	14.2
Concentration difficulties	24	25.6	16.6	45.8*	27.9	25.4	10.7	34*	22.7	26.7	28	21.4
Loss of memory	14.4	6.4	3.7	12.5	7.4	3	0	10	9	5.3	8	3.5
Tiredness	54.2	53.8	46.2	70.8	66.6	49	46.4	60	54.5	55.3	56	53.5
Sleep disturbances	18	12.8	12.9	12.5	25.9	5.8*	7.1	16	9	14.2	12	14.2
Discomfort			24	20.8	22.2	21.6	14.2	26	0	30.3*	10	46.4*
Burning sensation to the face			7.4	8.3	3.7	9.8	7.1	8	0	9	8	7.1
Pricking of the ear			16.7	16.7	22.2	15.7	14.2	20	13.6	19.6	8	35.7*
Warmth of the ear			53.7	58.3	59.2	54.9	46.4	62	36.3	64.3*	42	78.6*
In parenthesis: number of subjects. Results of chi-square test: $*=p<.05$ .												

>

observed in the group of cellular phone nonusers. Complaint frequencies for other general symptoms and for symptoms expressed during communication were not significantly different between men and women. The sex difference for sleep disturbances was not related to the model of cellular phone used (GSM or DCS—results not shown).

- 5) *Incidence of VDT use*: among digital cellular phones users (900 +1800 MHz), one general symptom, concentration difficulties, was significantly increased ( $p < .05$ ) for users of both cellular phone and VDT as compared to users of cellular phone only. Other general symptoms and symptoms expressed during communication were not significantly different.
- 6) *Incidence of calling duration per day*: complaint frequencies for discomfort and for warmth of the ear experienced during communication were significantly ( $p < .05$ ) more often reported when the calling duration per day was  $>2$  min, as compared to a calling time per day of  $< 2$  min.
- 7) *Incidence of number of calls per day*: complaints of discomfort, pricking sensation of the ear, and warmth of the ear reported during communication were significantly increased ( $p < .05$ ) when the number of calls per day was  $>2$  as compared to  $< 2$  calls per day.

## DISCUSSION

In our study, we did not observe a significant difference for general symptoms (headache, concentration difficulties, loss of memory, tiredness, sleep disturbances) between nonusers and users of cellular phones, even when we observed, as in the Chia et al.<sup>15</sup> study, an increased incidence of headache (+77%) is nonsignificant in our case. This result has to be put in perspective on considering the fact that nonusers of cellular phones were in fact, exposed to other electromagnetic sources they knew about (for example, in our study: 70% of them are exposed to VDT) or did not know about (microwaves from base station transmitters, radiofrequencies from radio and television transmitters, extremely low frequencies from electrical wiring, transformers, electric appliances, etc.). This situation may have affected results when we compared nonusers and users of cellular phones because people unexposed to electromagnetic fields are non-existent (at least in France). The lack of any difference between users and nonusers of cellular phones in general symptoms has also to be considered with the fact that, in our study, use of cellular phones by the subjects was not heavy, in mean, less than five calls per day and less than 15 min per day for call duration. In their study, Chia et al.<sup>15</sup> observed a significant increase of headache in users when call duration per day was  $> 60$  min.

Some of our results are in agreement with those obtained by Mild et al.<sup>14</sup> For example, we observed that two exposure factors, calling duration per day and number of calls per day, significantly increased complaints reported during communication, as warmth of the ear, pricking of the ear and general discomfort. For the other exposure factors we studied (duration of telephone ownership), no significant difference was observed for general symptoms or symptoms experienced during cellular phone use. As in the Mild et al.<sup>14</sup> study, we observed a significant difference in complaints about concentration difficulties in users of both cellular phones and VDT as compared to users of cellular phones only. We did not observe, for VDT and cellular phone users, the

significant increase in skin symptoms like the burning sensation of the face, as reported by Sandstrom et al.<sup>17</sup> for VDT users.

Some results obtained in our study are new. We observed a significant difference between women and men cellular phone users in complaints about sleep disturbances. This result, not observed in women and men nonusers of cellular phones, may be related to women's heightened sensibility to electromagnetic fields.<sup>18,19</sup> Our study shows also that 1800-MHz users reported a significant increase of concentration difficulties more often than 900-MHz users. This result has to be put in relation to factors like power density, microwave frequencies emitted by digital cellular phones, and factors which affect electromagnetic absorption by the human head.<sup>20</sup> Concentration difficulties observed here for 1800-MHz users may have been correlated with a short-term memory bioeffect of radiofrequency radiation.<sup>21</sup>

In a report of the UK independent expert group on mobile phones,<sup>22</sup> in line with precautionary approach, the expert group notes that individuals may choose to "use phones for as short a time as possible." Our results agree with this safe approach of the independent expert group, because nonspecific health symptoms (NSHS) are observed here, when calling duration per day is >2 min.

Our study showed, for three of the four symptoms experienced during cellular phone use (discomfort, pricking sensation on the ear, warmth of the ear), a significant increase in relation with the number of calls per day. This result has to be seen in relation to the fact that maximum electromagnetic energy is generated by a cellular phone at the beginning of the call.<sup>23</sup>

Electromagnetic fields emitted by digital cellular phones affect working memory in humans<sup>18</sup> and this effect may be related to cerebral vessel dilatation, attributed to brain heating.<sup>24</sup> It is well known also that microwaves increase the temperature of material from inside to outside.<sup>25</sup> Thus, we can say that the warmth sensation of the ear reported by digital cellular phone users during communication is the result, at the skin level, of mild cerebral hyperthermia. Thus, the warmth sensation of the ear might be a signal for users indicating that it is time to stop the call.

## CONCLUSION

This study has shown that digital cellular phone users more often complained of discomfort, warmth, and pricking on the ear during communication, as a function of the calling duration per day and the number of calls per day. The type of antenna of the cellular phone and the duration of telephone ownership had no significant effect on the incidence of complaints reported by digital cellular phone users.

Users of 1800-MHz (DCS) cellular phones complained significantly more often of concentration difficulties than 900-MHz (GSM) users. The combined use of cellular phones and VDTs significantly increased concentration difficulties in users of digital cellular phones.

In users of digital cellular phones, women complained significantly more often of sleep disturbances than men. This sex difference in sleep disturbance is not observed between women and men nonusers of cellular phones.

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# **‘The Physiological and Environmental Effects of Non-ionising Electromagnetic Radiation’**

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## **References**

## Abstract

This Study focuses upon an aspect of how living organisms, and humans, in particular, can be adversely affected by highly coherent electromagnetic fields of technological origin, in a way that is not entertained or addressed by existing Safety Guidelines – namely, through the possibility of non-thermal, frequency-specific influences of an informational nature. Supporting evidence is presented, and attention drawn to a disturbing consistency between some of these influences and the nature of certain adverse health effects found amongst some exposed people. On the basis of a detailed analysis of the present situation, a number of recommendations are made to promote a higher degree of electromagnetic biocompatibility between these fields and the alive human organism than currently obtains.

## EXECUTIVE SUMMARY

A major contemporary threat to the health of Society is man-made ‘electrosmog’. This non-ionising electromagnetic pollution of technological origin is particularly insidious, in that it escapes detection by the senses – a circumstance that, in general, tends to promote a rather cavalier attitude, particularly with respect to the necessity of ensuring an adequate degree of personal protection. Yet the nature of the pollution is such that there is literally ‘nowhere to hide’. Furthermore, given the relatively short time for which we have been exposed to it, we have no evolutionary immunity either against any adverse effects it might directly have on our alive organism or, indirectly, against its possible interference with certain electromagnetic processes of natural origin, which appear to be essential for homeostasis, such as, for example, the Schumann resonance – a weak electromagnetic field that oscillates resonantly in the cavity between the earth’s surface and the ionosphere at frequencies close to those of human brain rhythms, isolation from which has been found to be deleterious to human health. What distinguishes technologically produced electromagnetic fields from (the majority of) those of natural origin is their much higher degree of *coherence*. This means that their frequencies are particularly well-defined, a feature that facilitates the discernment of such fields by living organisms, including ourselves. This greatly increases their biological potency, and ‘opens the door’ to the possibility of frequency-specific, *non-thermal* influences of various kinds, against which existing Safety Guidelines – such as those issued by the International Commission for Non-ionising Radiation Protection (*ICNIRP*) - afford no protection. For these Guidelines are based solely on consideration of the ability of radio frequency (*RF*) and microwave radiation to heat tissue, and of extremely low frequency (*ELF*) magnetic fields to induce circulating electric currents in the interior of the body, both of which are known to be deleterious to health, if excessive. Since the severity of these effects increases with the strength (intensity) of the fields in question, it is this that the Guidelines restrict, in order to minimise associated adverse health effects, the frequency of the fields being taken into account *only* in so far as it affects (through ‘size’ resonance effects) the ability of the organism to absorb energy from the irradiating field and heat up accordingly. The Guidelines thus afford no protection against adverse health effects provoked *primarily* and *specifically* through influences that the *frequency* of the fields might have on the human organism.

A necessary condition for such an influence is the existence in the organism of the biological counterpart of an electrical tuned circuit – *i.e.* an endogenous oscillatory electrical activity. For then the organism can respond - in a way akin to a radio - if the frequency of the external

field (either of the carrier wave, or of lower frequency amplitude modulations/pulsings) matches, or is close to that of its tuned circuit, entailing, respectively, the possibility of either a resonant amplification of the associated endogenous biological activity – perhaps to an undesirably high level – or, deleterious interference with it. The possibility of such frequency-specific, non-thermal influences, unlike those addressed by existing Safety Guidelines, clearly requires, however, that the organism be *alive*, since only then does it support the endogenous electrical activities upon which its ability to detect external electromagnetic fields depends. Such influences can thus be considered to arise from a transfer of *information* (in a generalised sense) from the field to the alive organism, whereby the organism is able, through this kind of ‘oscillatory similitude’, to recognise – and in turn respond to – a feature of the external field *other than* its intensity. Equally important is that the external electromagnetic fields be sufficiently coherent to be discernible by the body against the level of its own incoherent thermal emission at physiological temperatures. Whilst this is usually the case, it should be noted that since the radiation is not perfectly coherent, the occurrence of non-thermal effects is still contingent upon a certain minimum intensity threshold, the magnitude of which is, however, *well below* that at which any discernible heating occurs.

A good example of such an ‘informational’, frequency-specific, non-thermal electromagnetic influence on the alive human organism is the ability of a light flashing at a certain *regular* rate to trigger seizures in people suffering from photosensitive epilepsy. The provocation of the seizure is primarily due, not to the brightness (intensity) of the light, but rather to the rate at which the light flashes – which, if close to the frequency of the particular electrical brain activity that is involved in epileptic seizures, can trigger their occurrence - *i.e.* the phenomenon is primarily a frequency-specific effect of information transfer from the light to the brain, the brain being able to ‘recognise’ the light through the rate at which it flashes. Existing intensity-based Safety Guidelines (relating to the visible part of the electromagnetic spectrum) afford no protection against such a (non-thermal) effect – unless, of course, they insisted on an intensity so low that the light was not visible!

Some oscillatory endogenous electrical activities of the alive human body are quite familiar - such as those of the heart and brain, which are monitored by an electrocardiogram and electroencephalogram, respectively; also equally familiar is the circadian rhythm. Others, however - such as the coherent electrical excitations at the cellular level, whose frequencies typically lie in the *microwave* region of the electromagnetic spectrum, and those, characterised by *ELFs*, pertaining to crucially important biochemical activities, involving, for example, the transport of calcium ions across cell membranes - are perhaps somewhat less well-known.

Accordingly, until the neglected frequency/information dimension of *non-visible* electromagnetic fields – such as (propagating) microwaves and other (non-propagating) electric and magnetic fields of technological origin, such as those from overhead power lines, for example - is recognised *in its own right*, these fields will continue to constitute a major potential threat to the living world in general, and to ourselves in particular. Since electromagnetic fields are so indispensable to the technology that Society is, understandably, reluctant to abandon, it is essential that a more comprehensive level of protection be developed, if this technology is to be used with a greater degree of safety than obtains at present. For, as has been explained, we are currently left vulnerable to any adverse health effects that might be provoked by non-thermal influences of the frequency dimension, which escape regulation by the existing intensity-based Safety Guidelines. Since, however, unlike intensity, the frequency aspect of the problem cannot be addressed by interventions pertaining to the aggressing field (without interfering with its frequency characteristics and informational content, the integrity of which must, of course, be maintained in

communication technologies, such as *GSM* telephony), it becomes necessary to consider strategies that target the *person* being irradiated – rather than the irradiating field itself - and devise ways whereby a higher degree of immunity than currently obtains can be realised. Such strategies are currently under development, and a number of related protection devices are already available commercially, although often their efficacy has not always been adequately demonstrated *biologically*. (There is an obvious parallel here with the pharmacological strategy of attempting to protect against bacterial infection, for example, by taking vitamin *C*, to fortify the immune system, rather than by wearing a protective mask to simply reduce the intensity of the bacterial field to which a person is exposed.)

It is thus essential that the domain of competence of existing Safety Guidelines be broadened by requiring that the familiar consideration of electromagnetic compatibility (*EMC*) between electromagnetic radiation and electronic instrumentation be extended *to include the alive human organism*, as an electromagnetic instrument itself, *par excellence*. The implementation of this ambitious programme of realising **electromagnetic biocompatibility** is an important task for the 21<sup>st</sup> century, and one that is shirked only at our peril.

Currently, there is much public concern over the possibility of adverse health effects provoked by both long *and* short-term exposure to electrosmog, particularly the contribution from overhead power lines and from *GSM* telephony. Quite justifiably, the public remains sceptical of attempts by governments and industry to reassure them that all is well, particularly given the unethical way in which they often operate symbiotically so as to promote their own vested interests, usually under the brokerage of the very statutory regulatory bodies whose function it supposedly is to ensure that the security of the public is *not* compromised by electromagnetic exposure! Given the recent experience with official duplicity over *BSE/CJD* – with the initial assurances of no risk and subsequent revelations of cover-ups - the public is now understandably wary of safety assurances from ‘official’ governmental scientific sources in respect of electromagnetic pollution; this is particularly so when the voice of those with a view contrary to that of the prevailing officially perceived wisdom is at worst silenced, or, at best, studiously ignored. The situation is further exacerbated by reports relating to research supported financially by the Mobile Phone Industry of its attempts to ‘persuade’ those who discover findings that might prove to be potentially damaging to market development *to actually alter their results* to make them more ‘market friendly’. Also no doubt driven by market considerations is the attempt (in which the World Health Organisation is playing a leading role) to establish a global ‘harmonisation’ of exposure standards, by attempting to persuade countries that currently operate more stringent limits – such as Russia and China - to relax them in favour of the higher levels tolerated in the West; it can be no coincidence that in Russia, where the frequency-specific sensitivity of living organisms to ultra-low intensity microwave radiation was first discovered over 30 years ago, that the exposure guidelines are approximately 100 times more stringent than those of *ICNIRP*!

Furthermore, there is a regrettable tendency to attribute market-friendly (negative) results a greater significance, publicity and profile than positive ones indicative of the possibility of adverse health impacts. An example of this is provided by the recent publication of the results of an epidemiological study in the *USA*, in which the statistically significant finding of an elevated risk amongst users of mobile phones of the incidence of a rare kind of tumour (epithelial neuroma) in the periphery of the brain – *precisely where there is maximum penetration of radiation from the mobile phone* (the laterality of which also correlated with phone usage) - was glossed over in the text of the paper, and completely escaped the attention of the media, who focused instead exclusively on the negative finding that there was no *overall* increase in the incidence of brain tumours amongst mobile phone users.

The mainstream scientific approach to assessing the noxiousness of human exposure to electromagnetic fields is principally guided by an essentially *linear* perception, which might well be adequate to deal with thermal effects, but is one that is quite inappropriate to any realistic consideration of the non-thermal, frequency-specific vulnerability of the alive human organism to the rather coherent electromagnetic fields of technological origin. For since, unlike thermal effects, the possibility of such non-thermal influences is contingent on the *aliveness* of the organism, their very occurrence as well as any implications for health necessarily both depend on the *state* of the organism when it is exposed, which, of course, varies not only between *different* individuals, but can also do so for the *same* individual, depending on his/her condition at the time of exposure – *i.e.* such influences are, technically speaking, inherently *non-linear* in nature. As such, they often appear bizarre from a linear standpoint - a feature that, together with difficulties sometimes experienced in attempts to independently replicate them, tends to bias their dismissal as experimental artefacts. Attempts to address a problem that is inherently non-linear from such a linear perspective only exacerbates things: outdated knowledge is worse than ignorance - at least the ignorant know what they do not know!

In the case of the mobile phone issue, not only has there been a reluctance on the part of official bodies to grasp this non-linear ‘nettle’, but there has also been a lamentable failure to inform themselves of, or pay adequate attention to, relevant and valuable indications of the potential noxiousness for humans and animals of exposure to pulsed microwave fields of sub-thermal intensity that have been long available - in particular, from experience with other kinds of installations (not least military ones) that utilise microwave radiation having certain features in common with that now used in *GSM* telephony. Thus it is not so much the case that, in the haste to make this new and valuable technology available to the public, the research necessary to establish its safety has been bypassed or compromised, but rather - and more reprehensibly – that already available indications that the technology is potentially less than safe have been (and continue to be) *studiously ignored*, not only by the mobile phone industry, but also by national and international regulatory bodies. A good example of this is afforded by the conduct of the UK National Radiological Protection Board, which was ‘unable’ to provide the Independent Expert Group on Mobile Phones (*IEGMP*) - for whom they were acting as the Secretariat - with certain highly relevant published papers, on the grounds that they could not ‘find’ them, despite having been provided with the full references by at least two individuals who gave evidence to the *IEGMP*, and curiously having had no difficulty in providing less significant papers from the *same issue* of the journal!

The genuine concerns of the public are thus not unfounded, and the irony of the present situation with respect to mobile phones and their base-stations is that the current Safety Guidelines afford a greater level of protection to electronic instrumentation than they do to the alive human being! Indeed, given the perceived lack of consensus amongst experts – concerning both the significance and credibility to be attached to published research into biological effects of the kind of radiation now used in *GSM* telephony, and whether such effects can actually provoke adverse health reactions in certain susceptible people (despite the existence of many consistent, anecdotal positive reports of such) - it is probably true to say that if same the level of concern and debate surrounded a new drug or foodstuff they would never be licensed!

Of particular concern to the public – and that which understandably generates the most outrage – is the involuntary subjection of certain groups of the population 24 hours/day, 7 days/week to the emissions of *GSM* base-stations, when they are insensitively sited near to homes, schools and hospitals. For the environment of these people is effectively permanently polluted - a pollution from which there is literally ‘nowhere to hide’. This totally unacceptable state of affairs raises serious ethical questions, and arguably contravenes the

Nuremberg Code, in that it is these people who will eventually reveal the degree to which chronic exposure to such fields is noxious – information that *is not currently available*: in other words, they are effectively involuntary subjects in a mass experiment.

This Study offers a perspective on the potential implications for human health of exposure to the pulsed microwave radiation currently used in *GSM* telephony, which differs somewhat from that currently espoused by mainstream science, but one that affords a much more holistic insight into the essential elements of the problem. Of particular importance is the emphasis given to (i) the fact that electromagnetic fields are not alien to the alive organism, but play a crucial role in controlling and maintaining its orderly functioning – *i.e.* that an alive organism is an electromagnetic instrument of great and exquisite sensitivity – (ii) the subjectiveness of human vulnerability, which necessarily follows from the inherently non-linear nature of the problem, which is here recognised *ab initio*, and (iii) the presence of *ELF* features both in the microwave pulsing of the signals from the antennae of mobile phones/base-stations *and* in the (much more penetrating) magnetic field associated with the surges of electric current from the battery of the handset that are necessary to realise the pulsed microwave emission. Indeed, it is here suggested that it is precisely through the presence of these *ELF* features that the emissions of a *GSM* phone and other related communication technologies, such as *TETRA*, can influence brain function - notably, its electromagnetic activity (brain-waves), its electrochemistry (including that of the neuroendocrine system, particularly with respect to melatonin levels) and the permeability of the blood-brain barrier, as well as altering cellular calcium ion concentrations. It is possible that this latter effect is only one particular facet of a more general disruptive influence that *ELF* fields can have on the integrity of essential ion-protein links (as suggested by recent Russian work) - an influence that could well be relevant also to consideration of bio-negative influences of exposure to *other* kinds of electromagnetic fields, such the low frequency magnetic fields associated with power lines and the mains appliances that they supply, which have been the subject of controversy for a much longer time.

The Study is structured as follows. Attention is first drawn to the irrationality of the currently prevailing situation that effectively affords – through electromagnetic compatibility regulations (*EMC*) - electronic instrumentation a higher level of protection against *GSM* radiation, for example, than do existing Safety Guidelines governing human exposure, which protect only against adverse health effects attributable to excessive heating, and not against those that might be provoked in some people by the radiation's *non-thermal*, frequency-specific interference with endogenous electromagnetic activities essential for homeostasis. To appreciate this more fully, it is explained why *GSM* signals are bio-active, and numerous examples given of frequency-specific, non-thermal biological influences that the kind of radiation currently used in *GSM* telephony can exert on a variety of living organisms, including humans.

Difficulties sometimes experienced in independent attempts to replicate these effects - which are frequently used to discredit positive results, and to dismiss them as artefacts of the particular experimental protocols used - are addressed, and possible reasons for discrepant results identified. The relevance to humans of findings obtained using animals, such as rats - which are often subject to exposure conditions quite different from those realised during human use of a mobile phone – is discussed, and, in the case of human studies, the importance of exposing the subjects to the emissions of a real mobile phone, rather than a 'surrogate', as is often done, stressed. Attention is then focused on the reality of adverse health impacts of both human and animal exposure to *GSM* and similar radiation, including that from military sources.

Although the occurrence of non-thermal influences *per se* does not, of course, necessarily entail adverse consequences for human health, the existence of disturbing consistencies between some of the published non-thermal effects of *GSM* radiation and the nature of certain reported adverse health effects, is cause for concern - particularly the recent report of an increased incidence amongst mobile phone users of a rare kind of brain tumour (notwithstanding the relatively short exposure time in comparison with typical latency periods), which is consistent with the genotoxicity of the radiation. Reasons why children must be considered potentially more at risk are identified, and what is possibly the most fundamentally significant point - namely that *not everyone* is necessarily adversely affected - addressed, as also are the implications of this on the validity of the familiar claim that there are no established adverse health effects of exposure to *GSM* radiation, provided its intensity conforms to the limits set by existing Safety Guidelines, which, it is argued, neglect the most discriminating feature of all - namely, the aliveness of the person exposed.

The Study concludes with a number of recommendations - which are detailed in the **STOA OPTIONS BRIEF** - for promoting an enhanced level of electromagnetic biocompatibility in the meanwhile, whilst the results of research currently in progress, and that planned for the near future - particularly longer term epidemiological studies - are awaited.

## **STOA OPTIONS BRIEF**

### **‘The Physiological and Environmental Effects of Non-ionising Electromagnetic Radiation’**

#### **1. Policy options for the European Parliament**

- That the non-emergency use of mobile phones by children - and particularly pre-adolescents - be strongly discouraged, on account of their increased vulnerability to any potential adverse health effects.
- That the Mobile Phone Industry be required to refrain from promoting the use of mobile phones amongst children by the use of advertising tactics exploiting peer pressure and other strategies to which the young are particularly susceptible, such as the (now discontinued) use of DISNEY characters fascias on the phones.
- That the Mobile Phone Industry be required to make it clear to the consumer that the value of the specific absorption rate (*SAR*) - which in some countries is shortly to be declared on the handset - refers *only* to the degree to which the microwave emissions from the antenna can heat biological tissue, and is in ***no way*** relevant to *non-thermal* effects that the emissions from a mobile phone may have on the user.
- Concerning commercially available personal protection devices claiming to protect the user of a mobile phone against the microwave emissions from the antenna, it be required that:
  - a*) The efficacy of devices such as shields and ear-pieces be proven on the basis of *biological tests*, and not marketed solely on the reduction in *SAR* value (as determined by the use of a ‘phantom’ head) that their use might achieve.
  - b*) It be made clear to the consumer that such devices afford no protection against the low frequency pulsed magnetic field from the battery of the phone.
- Concerning commercially available personal protection devices claiming work by boosting the immunity of the user against any adverse impacts of exposure (including those from the battery magnetic field), it be required that:
  - a*) The efficacy of such devices be established by biological testing.



*b)* Such devices not be rejected (as has occurred in certain consumer surveys that have been published) solely on the grounds that their use does not achieve any reduction in *SAR*, as measured using a ‘phantom’ head; for this is **not** what they are designed to do. Accordingly, the *SAR* is here a *fundamentally inappropriate* metric against which to assess their efficacy. [It should, however, be appreciated that in the case of *real human exposure* – as opposed to that involving a ‘phantom’ head – such devices could conceivably achieve a reduction in *SAR* if they somehow increase the efficiency of the body’s thermoregulatory mechanism; in this way, anecdotal reports of a diminution in heating sensation when a phone is equipped with one particular such device might be rationalised.]

## 2. Policy options for the European Commission

- Future research sponsored by the *EC*, should incorporate the following recommendations:
  - a)* That the living systems under investigation be exposed to the emissions of an actual mobile phone, as opposed to those of a ‘surrogate’, since the emissions from the former can be expected to have a quite different biological impact, in consequence of certain pulse frequency differences.
  - b)* That in assessing the significance to humans of results obtained using animals, particular attention be given to differences in exposure conditions, such as whether exposure is size-resonant or non-resonant, whether it is to the near or far field of the antenna, and whether whole-body or more localised exposure occurs.
  - c)* That systematic investigation be made into the influence of different kinds of pulsing (of real phones) on the human *EEG*, and ideally on the *MEG*, and of whether any observed changes in power spectra are correlated with changes in the level of deterministic chaos.
  - d)* That use be made of novel, non-invasive technologies, such as biophoton emission, to investigate the influence of mobile phone radiation on living systems.
  - e)* That in assessing the noxiousness of mobile phone radiation more attention be paid to lessons that have been learnt from exposure to other kinds of related radio frequency fields, such as those from the Skrunda, military and police radars.
  - f)* That, in the light of reports of cattle being quite seriously adversely affected at farms where there is a base-station, a veterinary monitoring service be established to collect and analyse such reports, and raise awareness amongst farmers of this potential hazard to their livestock.
- Attempts should be made – perhaps under the aegis of national regulatory bodies - to increase awareness of the fundamentally electromagnetic nature of the alive organism, and of its associated hypersensitivity to coherent, ultraweak electromagnetic signals of technological origin. [Until this is achieved, the necessity of extending existing thermally based safety guidelines, by incorporating therein the dimension of electromagnetic biocompatibility, is unlikely to be accepted, and the public will remain vulnerable to any adverse health effects provoked by non-thermal electromagnetic influences on the alive human organism.]

## 3. Technological options at the operational level

Whilst the question of precisely *how* adverse health effects can be provoked by non-thermal influences of the pulsed microwave radiation currently employed in *GSM* telecommunication, as well as those from *ELF* fields associated with other technologies, is far from resolved, the circumstantial evidence consistent with such influences suggests at least two ways in which biocompatibility with this technology could be enhanced by interventions involving the fields alone:

- In the case of exposure to *GSM* radiation, reduce intensities to the level below which no adverse effects have been empirically found in exposed populations, bearing in mind that there are indications of non-thermal thresholds for biological effects of the order of a *microwatt/cm<sup>2</sup>*. Power densities a few *tenths* of this value are common at distances of 150-200m from a typical 15m high Base-station mast and within the range of the more

localised side-lobes in the immediate vicinity of a mast - *adverse effects being reported at both locations*. Incorporating a further safety factor of 10 indicates that, at locations where there is any long-term exposure, power densities should not exceed 10 **nano**W/cm<sup>2</sup>. [To appeal to the (alleged) absence of health problems associated with the higher power density electromagnetic fields emitted by radio/TV transmitters in an attempt to justify the retention of the present level of emission from *GSM* Base-stations is *untenable*, on at least two accounts: (i) the nature of the emissions are quite different, with respect to carrier frequencies, modes of transmission (pulsed/analogue), and beam morphology, (ii) there *are* health problems connected with *some* such transmitters, contrary to what is often claimed!]

- Ensure that there are **no** *ELF* frequencies – either of amplitude modulations (including pulsing, as the extreme case) of *RF* fields, or of other electric /magnetic fields - in the range of human electrical brain-wave activity, or windows of calcium efflux. [In the case of exposure to *GSM* radiation, this will be achieved, to a certain extent, with the advent of the Third Generation of mobile phones (*UMTS*) that utilise *CDMA* in place of *TDMA*. For although any sensitivity to the microwave carrier will remain, the pulsing used in *CDMA* is *irregular*; accordingly, *CDMA* radiation cannot enjoy the same ‘oscillatory similitude’ with the human brain-wave activity and electrochemical processes as does *TDMA*. In consequence, however, of the somewhat higher carrier frequency used, which is closer to where water strongly absorbs microwaves, *thermal* effects could here become more of a problem, particularly in view of the somewhat higher powers at which they operate! The introduction of *TETRA*, on the other hand, gives rise to an *increased* level of both thermal *and* non-thermal concern.]

## Part A: OPTIONS

### 1. Policy options for the European Parliament

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- That the Mobile Phone Industry be required to make it clear to the consumer that the value of the specific absorption rate (*SAR*) - which in some countries is shortly to be declared on the handset - refers *only* to the degree to which the microwave emissions from the antenna can heat biological tissue, and is in **no way** relevant to *non-thermal* effects that the emissions from a mobile phone may have on the user.
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  - a*) The efficacy of devices such as shields and ear-pieces be proven on the basis of *biological tests*, and not marketed solely on the reduction in *SAR* value (as determined by the use of a ‘phantom’ head) that their use might achieve.
  - b*) It be made clear to the consumer that such devices afford no protection against the low frequency pulsed magnetic field from the battery of the phone.

- Concerning commercially available personal protection devices claiming work by boosting the immunity of the user against any adverse impacts of exposure (including those from the battery magnetic field), it be required that:

*a)* The efficacy of such devices be established by biological testing.

*b)* Such devices not be rejected (as has occurred in certain consumer surveys that have been published) solely on the grounds that their use does not achieve any reduction in *SAR*, as measured using a ‘phantom’ head; for this is **not** what they are designed to do. Accordingly, the *SAR* is here a *fundamentally inappropriate* metric against which to assess their efficacy.

[It should, however, be appreciated that in the case of *real human exposure* – as opposed to that involving a ‘phantom’ head – such devices could conceivably achieve a reduction in *SAR* if they somehow increase the efficiency of the body’s thermoregulatory mechanism; in this way, anecdotal reports of a diminution in heating sensation when a phone is equipped with one particular such device might be rationalised.]

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*c)* That systematic investigation be made into the influence of different kinds of pulsing (of real phones) on the human *EEG*, and ideally on the *MEG*, and of whether any observed changes in power spectra are correlated with changes in the level of deterministic chaos.

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*e)* That in assessing the noxiousness of mobile phone radiation more attention be paid to lessons that have been learnt from exposure to other kinds of related radio frequency fields, such as those from the Skrunda, military and police radars.

*f)* That, in the light of reports of cattle being quite seriously adversely affected at farms where there is a base-station, a veterinary monitoring service be established to collect and analyse such reports, and raise awareness amongst farmers of this potential hazard to their livestock.

- Attempts should be made – perhaps under the aegis of national regulatory bodies - to increase awareness of the fundamentally electromagnetic nature of the alive organism, and of its associated hypersensitivity to coherent, ultraweak electromagnetic signals of technological origin.

[Until this is achieved, the necessity of extending existing thermally based safety guidelines, by incorporating therein the dimension of electromagnetic biocompatibility, is unlikely to be accepted, and the public will remain vulnerable to any adverse health effects provoked by non-thermal electromagnetic influences on the alive human organism.]

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Whilst the question of precisely *how* adverse health effects can be provoked by non-thermal influences of the pulsed microwave radiation currently employed in *GSM* telecommunication, as well as those from *ELF* fields associated with other technologies, is far from resolved, the circumstantial evidence consistent with such influences suggests at least two ways in which biocompatibility with this technology could be enhanced by interventions involving the fields alone:

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[To appeal to the (alleged) absence of health problems associated with the higher power density electromagnetic fields emitted by radio/TV transmitters in an attempt to justify the retention of the present level of emission from *GSM* Base-stations is *untenable*, on at least two accounts: (i) the nature of the emissions are quite different, with respect to carrier frequencies, modes of transmission (pulsed/analogue), and beam morphology; (ii) there *are* health problems connected with *some* such transmitters, contrary to what is often claimed!]

- Ensure that there are **no** *ELF* frequencies – either of amplitude modulations (including pulsing, as the extreme case) of *RF* fields, or of other electric /magnetic fields - in the range of human electrical brain-wave activity, or windows of calcium efflux.

[In the case of exposure to GSM radiation, this will be achieved, to a certain extent, with the advent of the Third Generation of mobile phones (*UMTS*) that utilise *CDMA* in place of *TDMA*. For although any sensitivity to the microwave carrier will remain, the pulsing used in *CDMA* is *irregular*; accordingly, *CDMA* radiation cannot enjoy the same 'oscillatory similitude' with the human brain-wave activity and electrochemical processes as does *TDMA*. In consequence, however, of the somewhat higher carrier frequency used, which is closer to where water strongly absorbs microwaves, *thermal* effects could here become more of a problem, particularly in view of the somewhat higher powers at which they operate! The introduction of *TETRA*, on the other hand, gives rise to an *increased* level of both thermal *and* non-thermal concern.]

## Part B: ARGUMENTS and EVIDENCE

### B-1. Introduction: Electromagnetic Compatibility and Electromagnetic Bio-incompatibility

The importance of ensuring compatibility between activated electronic instrumentation of various kinds and the pulsed microwave radiation currently used in *GSM* mobile telephony is well recognised and generally accepted. Prohibition of the use of cellular phones on aircraft

and in hospitals, on the grounds that their emissions might adversely interfere with the operation of sensitive electronic equipment, is familiar, and their possible deleterious effect on personal medical devices, such as heart pacemakers, hearing aids, defibrillators and insulin pumps has been the subject of a number of published scientific studies in recent years. Given that it is inconceivable - at least in the case of aviation and hospital equipment - that the interference could arise from the heating effect of the radiation, some other, *non-thermal*, influence of the radiation must here (at least tacitly) be considered to be responsible. Unfortunately, however, the same considerations do not currently extend to the alive human organism, which is generally considered to be immune from adverse influences of *GSM* radiation, on account of its intensity<sup>1</sup> being far too low to cause any deleterious degree of body tissue heating, as quantified through the so-called specific absorption rate, or *SAR* - the rate at which the external electromagnetic field deposits energy in unit mass of the body, averaged over a certain period of time; for, contrary to case of electronic instrumentation, it is generally believed that for *humans* adverse effects can arise only from excessive heating. Indeed, this belief is reflected in the relative leniency of the Safety Guidelines<sup>2</sup> issued by the International Commission for Non-ionising Radiation Protection (*ICNIRP*), which permit humans to be exposed to electric fields that are *over ten times stronger* than the limit of 3V/m limit that is applicable to all electronic goods offered for sale in *EU* under current *EMC* legislation. on electromagnetic compatibility (*EMC*).

Despite the prevalence of this attitude - particularly amongst the various Regulatory Bodies, both national and international - it is not one that is universally held<sup>3</sup>, and the debate over the potential noxiousness of *GSM* radiation continues at both professional and public levels. What is so disturbing is if the same level of concern and uncertainty obtained in the case of a new food or drug, they would almost certainly never be licensed.

A good example of the prevailing disregard for what might be termed 'electromagnetic biocompatibility' is the development of *TETRA* (**T**rans **E**uropean/or **T**errestrial **E**nhanced **T**runked **R**adio **A**ccess), which operates at somewhat higher powers than does *GSM*, and over a much wider range of microwave carrier frequencies. Most disturbing, however, is the fact that the basic frame repetition rate is here 17.6Hz. For this frequency (which lies in the range of beta brain-wave activity) is close both to that at which a flashing visible light can provoke seizures in people with photosensitive epilepsy<sup>4</sup>, and to the modulation frequency at which there is a maximum in the expression of calcium ions from brain cells when they are irradiated with amplitude modulated, low intensity *RF* radiation over a wide range of carrier frequencies<sup>5-7</sup>; it should be remembered that these ions play a crucial role in inter-cellular communication, any interference with which could well undermine the integrity of the whole nervous system, although the extent to which this actually occurs is, at present uncertain, owing to a lack of the necessary research. Furthermore, in consequence of the lower frequency band assigned to the emergency services (380MHz - 400MHz), the penetration of the radiation is here much greater than it is with *GSM*, facilitating its deeper access into the brain directly through the skull.

## **B-2. Why *GSM* Signals are Bio-active**

That the low intensity, pulsed microwave radiation currently used in *GSM* telephony can exert subtle, non-thermal influences on the alive human organism arises, in the first place, because microwaves are, after all, *waves*, and, as such, have properties other than solely intensity. In particular, *GSM* radiation has certain rather well defined frequencies, which facilitate its discernment by the living organism, and *via* which the organism can, in turn, be affected. This is so because the *alive* human organism itself supports a variety of oscillatory electrical biological activities, each characterised by a particular frequency, *some of which*

*happen to be close to those used in GSM!*

The particular frequencies utilised in *GSM* that must be anticipated to be particularly ‘bio-active’ are those of the microwave carrier (900/1800 MHz) and those associated with certain pulsings that characterise the signal employed in the Time Division Multiple Access (*TDMA*) strategy that is used in *GSM* - specifically, the *multi*-frame repetition rate of 8.34Hz, and the 2Hz periodicity associated with the discontinuous transmission (*DTX*) mode of the phone – an energy saving mode that becomes active when the user is listening but not speaking. For there is evidence<sup>8</sup> that adequately metabolising systems themselves support highly organised, oscillatory electrical activities at the cellular level, whose frequencies generally lie in the **microwave** band, in terms of which the dramatic effects of ultra-low intensity microwaves of specific frequencies on processes as fundamental as cell division and intercellular communication can be understood in a rather natural way<sup>9</sup>. It should be noted that this endogenous microwave activity is a quite general (non-equilibrium) prediction of modern, non-linear biophysics<sup>10</sup> for living systems, under appropriate metabolic conditions.

The two *ELFs* (at 8.34Hz and 2Hz), on the other hand, correspond to those found in the human *EEG* - specifically, in the ranges of the alpha and delta brain-waves, respectively.

In the case of a *GSM* mobile phone, these two *ELFs* are reinforced by those of the essentially unscreenable **magnetic** fields associated with the current surges from the battery of the phone that are necessary in order to endow the microwave emission with the pulse characteristics required for *TDMA*. Peak magnetic field strengths as high as 40μT have been measured near the back of one particular model of phone<sup>11, 12</sup>, the noxiousness of which is indicated by recent experiments<sup>13, 14</sup> employing chick embryos, which reveal an *increased* degree of mortality when the phone is protected by a proprietary shielding device that reduces the microwave output. With the device in place, the increased (microwave) power output necessary to maintain contact with the base-station necessitates stronger surges of current, associated with which are correspondingly stronger (and evidently more noxious) *ELF* magnetic fields. These *ELF magnetic* fields could thus pose an even greater hazard to human health than do those associated with the microwave emission, a matter that warrants further experimental investigation. In this connection, mention should be made of recent theoretical advances<sup>15</sup> in understanding, at the quantum level, the disruptive influence that *ELF* fields (including pulsed ones) can have on the integrity of essential *ion-protein links*, resulting in an imbalance of intra and inter cellular ion concentrations; this can result in metabolism malfunction and high levels of stress that can be lethal to organisms in the early stages of development. It should be noted these ideas are also relevant to consideration of bio-negative influences of exposure to *other* kinds of electromagnetic fields, such the low frequency magnetic fields associated with power lines and the mains appliances that they supply, which have been the subject of controversy for a much longer time.

### **B-3. Indications of Non-thermal influences of Microwave Radiation, including GSM**

#### **3.1 *In vitro* and *in vivo* evidence**

Much experimental evidence of non-thermal influences of microwave radiation on living systems has been published in the peer reviewed, scientific literature during the last 30 years – relating both to *in vitro* and *in vivo* studies - including some obtained more recently under exposure to radiation both from a real *GSM* phone; most often, however, an experimental ‘surrogate’ microwave generator is used, the emissions of which can differ in certain important ways, the importance of which is not generally recognised (*see Section B-3.3*). It should also be appreciated that the fields to which the investigative systems are exposed in some of the earlier work are even farther removed from *GSM*, both with respect carrier

frequency, as well as CW/pulsed differences. A selection of some *in vitro* studies is given below in Table I.

**Table I**

<p>Epileptic activity in rat brain slices in conjunction with certain drugs<sup>16</sup>  Resonant enhancement of cell division in the yeast, <i>Saccharomyces cerevisiae</i><sup>17</sup>,  Resonant effect on the genome conformation of <i>Escherichia coli</i> cells<sup>18</sup>  Synchronisation of cell division in the yeast <i>Saccharomyces carlsbergensis</i><sup>19</sup> and in <i>E. coli</i><sup>20</sup>  ‘Switch-on’ of certain epigenetic processes, such as <math>\lambda</math>-phage<sup>21, 22</sup> and colicin synthesis<sup>23</sup>  Alteration in the activity of the enzyme orithine decarboxylase (<i>ODC</i>)<sup>24-26</sup>  Reduced efficiency of lymphocyte cytotoxicity<sup>27, 28</sup>  Increased permeability of the erythrocyte membrane<sup>29, 30</sup>  Effects on brain electrochemistry (calcium efflux)<sup>5-7</sup>  Increase of chromosome aberrations and micronuclei in human blood lymphocytes<sup>31</sup>  Synergistic effects with cancer promoting drugs such as phorbol ester<sup>32</sup></p>
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*In vivo* evidence of non-thermal influences, mainly under exposure to actual GSM phone radiation, comes predominantly from animal studies, some of which are summarised in Table II:

**Table II**

<p>Epileptiform activity in rats, in conjunction with certain drugs<sup>33</sup>  Depression of chicken immune systems (melatonin, corticosterone and IgG levels)<sup>13, 14</sup>  Increase in chick embryo mortality<sup>13, 14</sup>  Increased permeability of the blood-brain in rats<sup>34, 35</sup>  Effects on brain dopamine/ opiate electrochemistry<sup>36</sup>  Increases in <i>DNA</i> single and double strand breaks in rat brain<sup>37, 38</sup>  Promotion of lymphomas in transgenic mice<sup>39</sup>  Synergistic effects with certain psychoactive drugs<sup>40</sup>  Stressful effects in healthy and tumour bearing mice<sup>41</sup>  Neurogenetic effects and micronuclei formation in peritoneal macrophages in mice<sup>41</sup></p>
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Human *in vivo* studies, under GSM or similar conditions, include:

*I)* Effects on the human *EEG*, specifically, a delayed increase in spectral power density particularly in the alpha band<sup>42</sup>, which has been corroborated<sup>43</sup> in the awake *EEG* of adults exposed to GSM radiation. Influences on the asleep *EEG* have been reported, including a shortening of rapid eye movement (*REM*) sleep<sup>44</sup> (with possible adverse effects on learning) during which the power density in the alpha band again increases, and effects on non-*REM* sleep<sup>45</sup>. Exposure to mobile phone radiation also causes a significant decrease in the preparatory slow potentials in certain regions of the brain<sup>46, 47</sup>, and affects memory tasks<sup>48-50</sup>.

- 2) Observation of an increase in resting blood pressure during exposure<sup>51</sup>.
- 3) Observation of an increase in the concentration of nitric oxide in exhaled air correlated with mobile phone use, indicative of an elevated level of stress and inflammation<sup>52</sup>.
- 4) The established efficacy of Microwave Resonance Therapy<sup>53, 54</sup> – *i.e.* the possibility of re-storing homeostasis in a wide variety of human pathological conditions by ultra-weak microwave irradiation at specific frequencies under carefully controlled clinical conditions - otherwise known as ‘quantum medicine’, in view of the fact that such low intensities are used that individual quanta are involved. The existence of such positive effects of microwave irradiation makes it difficult to argue that such radiation can not have the opposite effect – *i.e.* a bio-negative one – when applied indiscriminately, and at higher intensities – in much the same way that the therapeutically beneficial effect of pharmaceutical drugs does not preclude the possibility of allergic drug reactions or, indeed, drug abuse.

Although, apart from in the latter case, the power density of the radiation used in these experiments is typically that found at the head when using a mobile phone, and thus much higher than that found in publicly accessible areas in the vicinity of a base-station, the *information* content of the radiation emitted by the latter is the same; accordingly, these results are *not* irrelevant to the consideration of potential adverse health effects associated with chronic exposure to base-station radiation.

### 3.2 Difficulties in replication

It should be noted that difficulties sometimes experienced in attempts to independently replicate certain frequency-specific non-thermal effects are *actually to be expected*. For in consequence of the highly non-linear, non-equilibrium nature of living systems, even the slightest differences in the physiological state of the biosystems used, and in the conditions obtaining in a particular experiment can, in consequence of deterministic chaos, assume singular importance<sup>55</sup>.

Quite apart from this problem, however, discrepant results can often be traced to certain differences in experimental protocols that only become apparent upon close scrutiny. Examples of this can be found in the attempt<sup>56</sup> to replicate the resonant influence of centimetre microwaves of sub-thermal intensity on cell division in the yeast *S. cerevisiae* found by Grundler *et al.*<sup>17</sup>, and the attempt by Malyapa *et al.*<sup>57</sup> to replicate the increase in *DNA* breakage under low intensity microwave irradiation found by Lai and Singh<sup>37, 38</sup>.

In the case of the yeast experiments, several features can be identified that could well account for the differing results, such as differences in the phase of the cell cycle at which exposure occurred, the use of synchronised cells in one experiment but not in the other, and differences in the imaging systems used (real-time *vs.* non-time lapse) to monitor cell division.

In the case of the *DNA* experiments, whilst both groups used microwave radiation of the same frequency, they irradiated different systems (live rats *vs.* a cell line), and used very different assays to assess the *DNA* damage; in addition, the replication attempt did not separate the (positively charged) bound protein from the (negatively charged) *DNA* strands, thus obtaining much less migration in the electrophoresis field, which was also applied for a much shorter time than in the original experiment; both these features militate against the formation of the ‘comet’ tails used to assess the degree of fragmentation.



### 3.3 Relevance of experiments to conditions realised in actual mobile phone usage

Quite apart from possible differences in the physiological states of the animals used in the original and replication experiments, it should not be overlooked that differences in irradiation conditions can also contribute to difficulties in achieving replication; in addition, they can also be a confounding factor in assessing the relevance of positive animal results to humans (as also, incidentally, can differences in the ratio of the duration of irradiation to the lifetime of the species in question.) Thus, for example, whereas, for humans, *whole-body* exposure is realised only in the case of a base-station, where ‘far-field’ conditions obtain, this is not necessarily so for animals, which, depending on their size, can be whole-body exposed to the *near-field* of a 900MHz phone antenna (or its experimental surrogate), the characteristics of which are quite different. In the case of humans, by contrast, use of a phone primarily results only in a rather *localised* exposure to the near-field of the antenna. A further factor to be remembered is that in many experiments, subjects are not exposed to the actual emission of an real *GSM* mobile phone, but rather to that of a ‘surrogate’ microwave generator whose the output can differ in certain crucial ways. For example, it may not even be pulsed, and even if it *does* so at the *GSM* frame repetition rate (217Hz), it most probably will **not** contain the (bioactive) *multi-frame* frequency of 8.34Hz, and certainly not the 2Hz that characterises the *DTX* mode.

### B-4. Indications of Non-thermal Adverse Health Impacts of Exposure to GSM and similar microwave radiation

The popular belief that adverse health effects can be induced only by the heating effect of *GSM* radiation is a fallacy:

1. There is rather consistent empirical, anecdotal evidence from many countries that the health of some people *is* adversely affected in various ways when they are exposed to this kind of radiation, despite its intensity being **well below** existing safety limits based on consideration of the *SAR*. It should be stressed that the *anecdotal* nature of many of the reported health problems – such as headache, sleep disruption, impairment of short term memory, nose bleeds and, more seriously, an increase in the frequency of seizures in some children already suffering from epilepsy - does **not** constitute grounds for dismissing them out of hand, as is so often advocated. For given the paucity, to date, of systematic epidemiological studies pertaining to this relatively recently introduced technology, such reports are an indispensable source of information – a point acknowledged in last year’s Report<sup>58</sup> of the *UK Commons’* Select Committee, dealing with the question of mobile phones and health.

2. More disturbingly, notwithstanding the absence of any *overall* increase in the incidence of brain tumours amongst users of mobile phones (mainly analogue ones, it should be emphasised), a statistically significant increase (by a factor of between 2 and 3) in the incidence of a rather rare kind of tumour (epithelial neuroma) in the periphery of the brain - *where the radiation has the greatest access* - the laterality of which correlates with mobile phone use, has been found<sup>59</sup> in an epidemiological study in the USA, as part of the *WTR* Programme<sup>60</sup>.

3. There is documented evidence<sup>61, 62</sup> that long-term (involuntary) exposure to microwave radiation of intensities intermediate between that realised near an active phone and that found in the vicinity of a base-station (but at somewhat different carrier frequencies than used in

*GSM*) does causes serious illness, such as leukaemia and lymphoma, in certain exposed people. This is the conclusion reached by a relatively recent reanalysis of the Lilienfeld report on the Moscow *US* Embassy irradiation during the 'cold' war, based on information that only became fully available following the Freedom of Information Act, which reveals that the original verdict of no serious health effects was, in fact, a sanitised version of Lilienfeld's findings, in which his statements of concern had been deliberately removed by the State Department.

4. A *US* Defence Intelligence Agency document<sup>63</sup> dated March 1976, reviewing Soviet work on biological effects of non-thermal exposure to microwave and radiofrequency radiation makes interesting, but disturbing, reading. For not only have many of the effects there reported now been found in the case of exposure to *GSM* telephony radiation, but the following extract (which, incidentally, was eventually also removed) reveals a less known 'dark side' of the issue that is consistent with the Moscow Embassy affair, and one that presaged – as it turned out – the subsequent deployment of this kind of radiation in psychotonics and other forms of non-lethal microwave weaponry:

*'The potential for the development of a number of antipersonnel applications is suggested by the research published in the USSR, East Europe and the West. Sounds and possibly even words which appear to be originating intracranially can be induced by signal modulation at very low average power densities. Combinations of frequencies and other signal characteristics to produce other neurological effects may be feasible in several years. The possibility of inducing metabolic disorders also suggested. Animal experiments reported in the open literature have demonstrated the use of low level microwave signals to produce death by heart seizure or by neurological pathologies resulting from breaching of the blood-brain barrier'.*

5. An invaluable indicator of the potential noxiousness of the pulsed microwave fields emitted by base-stations is the increasing number of reports – some published, some as yet anecdotal – of adverse effects on the health and well-being of various animal species, specifically cattle, dogs, birds and bees. In the case of the affected cattle reported in one particular study<sup>64</sup>, the cattle (which were found to line up, all facing away from the mast) displayed a variety of problems, including severely reduced milk yields, emaciation, spontaneous abortions, and still births. Especially relevant are the following facts: (i) the condition of the cattle was found to improve dramatically when they were removed to pastures well away from the mast, only to deteriorate again once they were brought back, (ii) the adverse effects appeared only *after* *GSM* microwave antennae had been erected on a tower that had formerly been used to transmit only (analogue) TV and radio signals, associated with which there had, in this case, been *no* evident health problems. It should be noted that this is not an isolated occurrence, similar problems with cattle being reported from elsewhere<sup>65</sup>. In the case of domestic canine pets, there are a number of anecdotal reports of their immune systems being adversely affected, again in a *reversible* way. Finally, there are reports of declines in bird and bee populations following the commissioning of new base-station masts.

It should be noted that the occurrence of adverse effects in *animals* is particularly significant, in that it indicates that the effects are real, and not psychosomataical, as is often claimed, in the case of humans exposure, by those who maintain that base-station radiation is harmless. Furthermore, given that animals are often more highly electrosensitive than are humans, the serious nature of the health problems they have manifested over such a relatively short period of time could well portend a correspondingly serious noxiousness in the case of *long-term*

exposure of humans, and constitute a valuable early-warning system, similar to the 'canary down the mine'!

6. It is of interest, and probably highly significant, to note that some of the *same* symptoms have been reported in epidemiological studies (involving animals and plant life, in addition to humans), connected, not with mobile phone base-stations, but with *other* kinds of installations operating at somewhat lower frequencies - specifically, a Short-wave radio transmitter<sup>66</sup>, and a radar<sup>67</sup>, the latter being at 154-162MHz, with a pulse repetition frequency of 24.4Hz - at locations where the intensity of the emitted radiation is *comparable* to that typically found at 150m from a base-station. Additional effects include:

i) Depressed nocturnal melatonin levels in cattle<sup>66</sup>.

ii) Less developed memory and attention span (as well as decreased endurance of their neuromuscular apparatus) of children<sup>68</sup> living within a 20km radius of the radar, subject to a maximum exposure of  $0.039\mu\text{W}/\text{cm}^2$ .

iii) A six-fold increase in chromosome damage in cows<sup>69</sup> exposed to a likely maximum intensity of  $0.1\mu\text{W}/\text{cm}^2$ .

(The cited field intensities are estimated from information on the electric field intensity as a function of distance from the radar installation, given in Ref. 70.)

*In each case, the unexposed population to the rear of the beams constituted the control group.*

7. At somewhat higher intensities, but still well below the exposure limits permitted by the ICNIRP Guidelines, is a 2-fold increase in the incidence of cancer amongst Polish military personnel, which has been revealed by a long term, on-going study<sup>71</sup>.

With respect to the apparent absence to date of such serious, life-threatening adverse effects in the case of human exposure to GSM base-station radiation, it should be noted that this is no guarantee of immunity against *long-term* (or chronic) exposure. For exposure to this kind of radiation is still in its 'early days' in comparison to the much longer (10-15 years) latency period of the kinds of cancers that might be initiated or promoted in certain people.

Partly responsible for the reluctance to accept the reality of the underlying non-thermal effects is not only their often counter-intuitive nature - as exemplified, for instance, by the fact that they often become more marked as the strength of the irradiating field *decreases* - but also the difficulties sometimes experienced in attempts to replicate them, as already mentioned in **Section 3.2**. On the other hand, the equal reluctance to accept that they can provoke adverse health reactions in some people can be attributed - at least in part - to a general lack of appreciation that electromagnetic fields are **not alien** to an alive organism, but actually play a rather fundamental and integral role in its organisation and control, from the cellular level upwards<sup>72-74</sup> - *i.e.* that an alive organism is *itself* an electromagnetic instrument of great and exquisite sensitivity, and, as such, is just as vulnerable to being deleteriously interfered with (non-thermally) by external electromagnetic fields as is an activated piece of electronic equipment, (although in the latter case the influence of a given field is always the *same*, unlike the situation with an alive organism.)

## B-5. From Non-thermal Effects to Adverse Health Effects

The hypersensitivity of the alive human organism to ultraweak microwave radiation is reflected in the ways in which this kind of radiation has been found to affect a wide variety of brain functions, as already noted in **Section B-3.1** - such as electrical activity (*EEG*)<sup>42-50</sup>, electrochemistry<sup>5-7, 24-26, 36</sup>, and the permeability of the blood/brain barrier<sup>34, 35</sup> - and to degrade the immune system<sup>13, 14, 27, 28</sup>. Although these effects do not necessarily entail adverse health consequences, there is an undeniable *consistency*<sup>75</sup> between some of these non-thermal influences and the nature of many of the health problems reported, such as headache, sleep disruption, impairment of short term memory, and, more seriously, significant increases in the frequency of seizures in some epileptic children when exposed to base-station radiation, and of brain tumours amongst users of mobile phones; it must, however, be admitted that precisely *how* these influences actually provoke adverse health reactions is at present unclear. Thus, the reports of:

*a)* Headache are consistent with the fact that microwaves are known to non-thermally affect the dopamine-opiate system of the brain<sup>36</sup> and to increase the permeability of the blood-brain barrier<sup>34-35</sup>, since both of these have been medically connected with headache<sup>77-82</sup>.

*b)* Sleep disruption are consistent with the effect of *GSM* radiation on rapid eye movement (*REM*) sleep<sup>44</sup> and on melatonin levels<sup>13, 14</sup> - the latter being found also epidemiologically, in the case of *RF* exposure<sup>66</sup>.

*c)* Memory impairment is consistent with the finding that microwave radiation targets the hippocampus<sup>16</sup>.

*d)* Since there is no reason to suppose that the seizure inducing ability of a flashing *visible* light does not extend<sup>83</sup> to (invisible) **microwave radiation** (which can access the brain directly through the skull) flashing at a similarly low frequency, together with the fact that exposure to this kind of radiation is *known* to induce epileptic activity in certain animals<sup>33</sup>, reports<sup>84</sup> of *increased* seizure activity in some children that already suffer from epilepsy are perhaps not surprising.

*e)* The statistically significant increase in the incidence of amongst users of mobile phones in the incidence of epithelial neuroma is consistent both with the *genotoxicity* of low intensity microwave radiation, as indicated by the increased number<sup>37-38</sup> of *DNA* strand breaks<sup>85</sup>, the formation of chromosome aberrations and micronuclei in human blood<sup>31</sup> (the latter being corroborated in the case of *GSM* radiation by the *WTR* Programme<sup>60</sup>), and with the *promotional* effect of *GSM* radiation in the case of transgenic mice that had been genetically engineered to have a predisposition to develop cancer<sup>39</sup>.

## B-6. The Increased Vulnerability of Pre-adolescent Children

Pre-adolescent children can be expected to be (potentially) more at risk than are adults - as recognised in the recently published Report<sup>86</sup> of the UK Independent Expert Group on Mobile Phones - for the following reasons:

- i)* Absorption of microwaves of the frequency used in mobile telephony is greatest<sup>87</sup> in an object about the size of a child's head - the so-called 'head resonance' - whilst, in consequence of the thinner skull of a child, the penetration of the radiation into the brain is greater than in an adult.
- ii)* The still developing nervous system and associated brain-wave activity in a child (and particularly one that is epileptic) are more vulnerable to aggression by the pulses of

microwaves used in *GSM* than is the case with a mature adult. This is because the multi-frame repetition frequency of 8.34Hz and the 2Hz pulsing that characterises the signal from a phone equipped with discontinuous transmission (*DTX*), lie in the range of the *alpha* and *delta* brain wave activities, respectively. The fact that these *two* particular electrical activities are constantly changing in a child until the age of about 12 years – when the delta-waves disappear and the alpha rhythm is finally stabilised – means that they must *both* be anticipated to be particularly vulnerable to interference from the *GSM* pulsing.

- iii) The increased mitotic activity in the cells of developing children makes them more susceptible to genetic damage.
- iv) A child's immune system, whose efficiency is, in any case, degraded by radiation of the kind used in mobile telephony, is generally less robust than is that of an adult, so that the child less able to 'cope' with any adverse health effect provoked by (chronic) exposure to such radiation.

### **B-7. But Not Everyone is Adversely Affected**

Because both the occurrence of the initial provoking non-thermal effect *as well as* the severity of any associated adverse health effect depend on aliveness, they *necessarily depend on the physiological state of the organism when it is exposed to the radiation* - i.e. non-thermal effects are *non-linear* effects. Accordingly, it is quite possible that exposure to a low intensity field can entail a seemingly disproportionately *large* (non-linear) response (or none at all), and *vice versa* (consistent with which is the familiar occurrence of 'windows' of response), quite unlike the situation with the predictable (linear) thermal effects.

Since the physiological state of different people cannot, however, be anticipated to be the same – depending as it does on factors such as the stability of an individual's brain rhythms against interference or entrainment by the radiation, their already prevailing level of stress, and the robustness of their immune system – it follows that *identical* exposure to exactly the *same* radiation can entail quite different (non-thermal) responses in different people (or even in the same person, depending on his/her condition at the time of exposure<sup>88</sup>), quite unlike the case of active electronic instruments. This is, of course, consistent both with the fact that not every exposed person is adversely affected (as is also the case with smoking\*, for example,

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\* In the case of smoking, it is often claimed that the odds ratio is here much higher than it is in the case of electromagnetic exposure; but this is *necessarily so*, because the former compares heavy smokers with non-smokers, of whom there is effectively no electromagnetic counterpart, everyone being unavoidably at least lightly exposed.

where not all smokers get lung cancer!) and with the difficulties encountered in some laboratory attempts to replicate non-thermal effects, particularly under *in vivo* conditions. For depending on a person's genetic predisposition, and the fact that stress is cumulative, it is quite possible that exposure to an electromagnetic field simply supplies the final contribution that raises a particular person's level of stress above some critical value, thereby 'triggering' the manifestation of some pathology that is already in a well advanced state, but which, in the absence of any exposure, would have remained latent. On the other hand, as already mentioned in **Section B-3.2**, difficulties sometimes experienced in attempts to independently replicate certain frequency-specific non-thermal effects are *actually to be expected*, in consequence of the highly non-linear, non-equilibrium nature of living systems, whereby even the slightest differences in the physiological state of the biosystems used and in conditions obtaining in a particular experiment can, in consequence of deterministic chaos, assume singular importance.

Accordingly, the oft-repeated statement that .....‘*There are no established adverse health effects of exposure to GSM radiation (of sub-thermal intensity)*’ ..... is actually quite true, but, in view of the above, this is **necessarily so**, thus making the statement essentially vacuous. The more relevant consideration is whether there is an established **risk** to human health. It must be concluded that such a risk does indeed exist, but - in view of the above considerations- the actual number and identity of those at risk are necessarily unknown, *a priori*, although, for the reasons identified, children and highly stressed people - particularly those with already compromised immune systems (as well as those on certain prescribed psychoactive drugs) - must be considered more vulnerable.

For the Mobile Phone Industry, regulatory bodies and government to deny this risk is not only untenable, but also, more significantly, lays them open to the charge that they attempted to ‘*shield the public from uncertainty*.’<sup>89</sup>. There is nothing to be lost - and a lot to be gained - by frankly admitting the existence of this risk, albeit possibly only to a minority of the public, and, in accordance with the recommendations of the Stewart Report<sup>86</sup>, taking the necessary steps to minimise it, such as those specified in **Part A**

## **B-8. The Inadequacy of Existing Safety Guidelines**

Existing Safety Guidelines, based solely on consideration of the *SAR*, afford no protection against the **frequency**-specific<sup>90</sup> effects that have been the subject of this Study, since they limit only the *intensity* of the microwave radiation sufficiently to ensure that tissue heating by absorption of energy from the microwaves is not in excess of what can be coped with by the body’s thermoregulatory mechanism, so that temperature homeostasis is not compromised. Furthermore, it must be appreciated that the aliveness of the organism here enters only in so far as it dictates the magnitude of the temperature rise above which adverse health effects set in, the *heating itself* occurring *irrespective* of whether the organism is alive or dead.

In justifying the exclusion of any *non-thermal* input into the formulation of their Safety Guidelines, *ICNIRP* conclude<sup>2</sup>:

.....‘*Overall, the literature on athermal effects of amplitude modulated electromagnetic fields is so complex, the validity of the reported effects so poorly established, and the relevance of the effects to human health is so uncertain, that it is impossible to use this body of information as a basis for setting limits on human exposure to these fields.*’

It is to be stressed that this is **not equivalent to denying the existence of non-thermal influences of this kind of radiation, or their potential to provoke adverse health reactions** - as is often maintained by the Mobile Phone Industry – but simply that in *ICNIRP*’s view (because for the reasons stated) such effects cannot be used as a basis for setting exposure limits. Let us consider each point in turn. As an example of the complexity of athermal (*i.e.* non-thermal) effects, the following statement appears in the paragraph preceding the one from which the above quotation is taken:

.....‘*Interpretation of several observed biological effects (of this kind of radiation) is complicated by the apparent existence of ‘windows’ of response in both power and frequency domains. There are no accepted models that adequately explain this phenomenon, which challenges the traditional concept of a monotonic relationship between the field intensity and the severity of the resulting biological effects.*’

An absence of such a monotonic ('dose-response') relationship is, however, actually to be *expected*, since one is dealing with **living** organisms whose very aliveness means that they are far from thermal equilibrium, and hence well beyond the regime where such a monotonic relationship can be expected to hold. Being held far from thermal equilibrium, their response to an external electromagnetic field, for example, necessarily depends on the *state* of the organism at the time when it is exposed - *i.e.* one is dealing with what are known as **non-linear** systems, for which exposure to a weak microwave field does not necessarily entail a correspondingly weak response, or *vice versa*, and for which the 'window' phenomena referred to are actually to be expected<sup>9, 10</sup>! (In this connection, it should be remembered that the concept of a dose-response relationship is one inherited from toxicology, and as such, is in general, *inappropriate* in the present context. For electromagnetic fields are *not alien* to the alive organism, but play a fundamental and integral role in its organisation and control, as already noted.)

This dependence of non-thermal influences on the state of the alive organism must, in general, be expected to undermine the reproducibility of their detection, thus accounting for the reported effects being (in some cases) '*poorly established*'. Accordingly, such difficulties should, more positively, be considered as a biological fact of life – indeed as a 'hallmark' of aliveness! It should be noted that the 'poorly established' claim is not universally accepted, as evidenced both by the Vienna Resolution<sup>3</sup> of 1998, signed by 16 researchers of international standing, and by a recent analysis<sup>91</sup> of the ICNIRP document, which claims that it contains....'*a consistent pattern of bias, major mistakes and deliberate misrepresentations*'.

The least contentious part of the quotation is, of course, the question of the relevance of non-thermal effects (assuming their existence is accepted) to human health - it being, of course, essential to appreciate that the occurrence *per se* of non-thermal effects does not mean that they *necessarily* entail adverse health consequences, as already stressed.

In order that the radiation can exert *non-thermal* influences, it is essential that the organism be **alive**, for only then are the various oscillatory endogenous electrical activities excited, *via* which the radiation can access the system: the Dead have no *ECG* or *EEG* with which an external electromagnetic field can interfere! Thus, just as a radio or another piece of electronic instrumentation has to be switched on (or energised) before it can respond to or be interfered with by an extraneous incoming signal, so the organism has itself to be energised (*i.e.* be alive) if it is to be non-thermally sensitive to radiation. *Existing Safety Guidelines thus neglect the most discriminating feature of all, namely, the **aliveness** of the irradiated organism*; they address only 'one side of the coin' - the thermal side - leaving the exposed person vulnerable to the possibility of adverse health effects provoked by the neglected *non-thermal* side. The same indictment, of course, applies to any protection device that acts simply to reduce - either by screening or by employing an ear-piece, for example - the intensity of the microwave radiation emitted by a mobile phone into the head of the user; for the user is still left vulnerable to any adverse health effects that might be provoked by the neglected frequency dimension.

Clearly, non-thermal influences are connected more with the transfer of **information** from the irradiating field to the alive organism, through the latter's ability to 'recognise' certain **frequency** characteristics of the radiation<sup>92</sup>, than with its ability to absorb energy from the field. In order, however, for the organism to be able to discern such weak radiation against the level of its own thermal *emission* at physiological temperatures, the radiation must have a certain minimum intensity. In the case of microwave radiation, this minimum intensity is, however, *far below* (of the order of  $10^{-15}$  Watts/cm<sup>2</sup>) even that at which *non-thermal* effects

manifest themselves, in consequence of the radiation's rather well-defined carrier frequency (or relatively high degree of coherence). It should be noted that the magnitude of this minimum power density is close to those that characterise the human thresholds of *EEG* response<sup>93</sup>, and also of sight and hearing. Given that the typical power densities in the main beam near ground level some hundreds of metres from a typical base-station, and also in the often neglected 'side-lobes', are many orders of magnitude *higher* than these threshold values, it is clear that the ability of the alive human organism to discern base-station radiation is *not* at all contingent on a sensitivity that is in any way superior to those that it already possesses (quite undisputedly) in the case of other exogenous fields of physiological relevance.

## **B-9. Some recommendations to enhance electromagnetic bio-compatibility**

### **9.1. Policy options for the European Parliament**

- That the non-emergency use of mobile phones by children – and particularly per-adolescents – be strongly discouraged, on account of their increased vulnerability to any potential adverse health effects.
- That the Mobile Phone Industry be required to refrain from promoting the use of mobile phones amongst children by the use of advertising tactics exploiting peer pressure and other strategies to which the young are particularly susceptible, such as the (now discontinued) use of DISNEY characters fascias on the phones.
- That the Mobile Phone Industry be required to make it clear to the consumer that the value of the specific absorption rate (*SAR*) - which in some countries is shortly to be declared on the handset - refers *only* to the degree to which the microwave emissions from the antenna can heat biological tissue, and is in *no way* relevant to *non-thermal* effects that the emissions from a mobile phone may have on the user.
- Concerning commercially available personal protection devices claiming to protect the user of a mobile phone against the microwave emissions from the antenna, it be required that:
  - a)* The efficacy of devices such as shields and ear-pieces be proven on the basis of *biological tests*, and not marketed solely on the reduction in *SAR* value (as determined by the use of a 'phantom' head) that their use might achieve.
  - b)* It be made clear to the consumer that such devices afford no protection against the low frequency pulsed magnetic field from the battery of the phone.
- Concerning commercially available personal protection devices claiming work by boosting the immunity of the user against any adverse impacts of exposure (including those from the battery magnetic field), it be required that:
  - a)* The efficacy of such devices be established by biological testing.
  - b)* Such devices not be rejected (as has occurred in certain consumer surveys that have been published) solely on the grounds that their use does not achieve any reduction in *SAR*, as measured using a 'phantom' head; for this is **not** what they are designed to do. Accordingly, the *SAR* is here a *fundamentally inappropriate* metric against which to assess their efficacy.

[It should, however, be appreciated that in the case of *real human exposure* – as opposed to that involving a 'phantom' head – such devices could conceivably achieve a reduction in *SAR* if they



somehow increase the efficiency of the body's thermoregulatory mechanism; in this way, anecdotal reports of a diminution in heating sensation when a phone is equipped with one particular such device might be rationalised.]

## 9.2 Policy options for the European Commission

- Future research sponsored by the *EC*, should incorporate the following recommendations:
  - a*) That the living systems under investigation be exposed to the emissions of an actual mobile phone, as opposed to those of a 'surrogate', since the emissions from the former can be expected to have a quite different biological impact, in consequence of certain pulse frequency differences.
  - b*) That in assessing the significance to humans of results obtained using animals, particular attention be given to differences in exposure conditions, such as whether exposure is size-resonant or non-resonant, whether it is to the near or far field of the antenna, and whether whole-body or of more localised exposure occurs.
  - c*) That systematic investigation be made of the influence of different kinds of pulsing (of real phones) on the human *EEG*, and ideally on the *MEG*, and of whether any observed changes in power spectra are correlated with changes in the level of deterministic chaos.
  - d*) That use be made of novel, non-invasive technologies, such as biophoton emission, to investigate the influence of mobile phone radiation on living systems.
  - e*) That in assessing the noxiousness of mobile phone radiation more attention be paid to lessons that have been learnt from exposure to other kinds of related radio frequency fields, such as those from the Skrunda, military and police radars.
  - f*) That, in the light of reports of cattle being quite seriously adversely affected at farms where there is a base-station, a veterinary monitoring service be established to collect and analyse such reports, and raise awareness amongst farmers of this potential hazard to their livestock.
- Attempts should be made – perhaps under the aegis of national regulatory bodies - to increase awareness of the fundamentally electromagnetic nature of the alive organism, and of its associated hypersensitivity to coherent, ultraweak electromagnetic signals of technological origin.

[Until this is achieved, the necessity of extending existing thermally based safety guidelines, by incorporating therein the dimension of electromagnetic biocompatibility, is unlikely to be accepted, and the public will remain vulnerable to any adverse health effects provoked by non-thermal electromagnetic influences on the alive human organism.]

## 9.3 Technological options at the operational level

Whilst the question of precisely *how* adverse health effects can be provoked by non-thermal influences of the pulsed microwave radiation currently employed in *GSM* telecommunication, as well as those from *ELF* fields associated with other technologies, is far from resolved, the circumstantial evidence consistent with such influences suggests at least two ways in which biocompatibility with this technology could be enhanced by interventions involving the fields alone:

- In the case of exposure to *GSM* radiation, reduce intensities to the level below which no adverse effects have been empirically found in exposed populations, bearing in mind that there are indications of non-thermal thresholds for biological effects of the order of *microwatt/cm<sup>2</sup>*. Power densities a few *tenths* of this value are common at distances of 150-200m from a typical 15m high Base-station mast and within the range of the more

localised side-lobes in the immediate vicinity of a mast - *adverse effects being reported at both locations*. Incorporating a further safety factor of 10 indicates that, at locations where there is any long-term exposure, power densities should not exceed 10 nanoW/cm<sup>2</sup>.

[To appeal to the (alleged) absence of health problems associated with the higher power density electromagnetic fields associated with radio/TV transmissions in an attempt to justify the retention of the present level of emission from GSM Base-stations is untenable on at least two accounts: (i) the nature of the emissions are quite different, with respect to carrier frequencies, modes of transmission (pulsed/analogue), and beam morphology, (ii) there *are*<sup>94-96</sup> health problems connected with *some* such transmitters, contrary to what is often claimed!]

- Ensure that there is **no** *ELF* frequencies – either of amplitude modulations (including pulsing, as the extreme case) of *RF* fields, or of other electric /magnetic fields - in the range of human electrical brain-wave activity, or windows of calcium efflux.

[In the case of exposure to GSM radiation, this will be achieved, to a certain extent, with the advent of the Third Generation of mobile phones (*UMTS*) that utilise *CDMA* in place of *TDMA*. For although any sensitivity to the microwave carrier will remain, the pulsing used in *CDMA* is *irregular*; accordingly, *CDMA* radiation cannot enjoy the same ‘oscillatory similitude’ with the human brain-wave activity and electrochemical processes as does *TDMA*. In consequence, however, of the somewhat higher carrier frequency used, which is closer to where water strongly absorbs microwaves, *thermal* effects could here become more of a problem, particularly in view of the somewhat higher powers at which they operate! The introduction of *TETRA*, similarly gives rise to an *increased* level of (non-thermal) concern, for the reasons already stated in **Section B-1**.]

## B-10. Conclusions

Absorption of microwave radiation causes heating of biological tissue, which if excessive is deleterious to health; this is undisputed, and forms the basis of current Safety Guidelines, both national and international. In the case of exposure to the microwave radiation used in *GSM*, these Guidelines are generally not violated. Indeed, in the case of the emissions from base-stations, it has been repeatedly confirmed by field measurements that the emissions are *far* below - by many orders of magnitude - the limits set by the Guidelines. What *is* currently disputed, however, is whether, in the case of the alive human organism, this radiation can exert other, more subtle, kinds of non-thermal influences, which might also entail adverse health consequences. The root of the continuing public concern is that if this is, in fact, the case, then the existing guidelines afford an inadequate level of protection, in that they leave an exposed person vulnerable to these non-thermal hazards.

As has been explained, the heating ability of microwave radiation depends primarily on its intensity, and it is essentially only this that the Guidelines restrict. *Non-thermal* effects, on the other hand, depend primarily on the existence of an ‘oscillatory similitude’ between the frequencies of the radiation and those of certain endogenous biological electrical activities that the organism supports when alive, which effectively opens it to informational aspects of the radiation; it is this dimension of the problem that is not addressed by existing Safety Guidelines.

Whilst the existence of non-thermal influences is readily accepted in the case of active electronic instrumentation exposed to *GSM* radiation, the same does not currently prevail in the case of the alive human organism, which is generally considered immune to any effect other than heating, despite the fact that, in the case of mobile phone use, the brain (the most sensitive organ of the body) is, for the first time in its evolutionary history, being exposed at short range to a source of both pulsed microwaves (from near-field of the antenna) and more highly penetrating *ELF* magnetic fields (from the battery). This conviction continues to

persist - particularly in Regulatory Circles - despite the fact that the possibility of non-thermal influences on living systems of the kind of radiation used in mobile telephony is a rather general prediction of modern, non-linear biophysics, and one that is supported by 30 years of evidence, both of non-thermal effects *per se*, and of associated adverse health reactions, in particular – not only from exposure to GSM radiation, but also to that from other kinds of installations that emit microwave and *RF* radiation of an intensity at locations of human and animal exposure that is comparable to that realised several hundreds of metres from a base-station.

Two principal reasons for this state of affairs have been identified: 1) the negative outcome of some attempts to independently replicate certain non-thermal effects, even *in vitro*, the acceptance of which is not helped by their often counterintuitive nature (but only from a linear perspective), and 2) uncertainty as to whether such effects (assuming they *are* real) necessarily entail adverse health reactions. Both these problems have been addressed, and attention drawn (*i*) to the fact that difficulties in corroboration are actually to be expected as a hall-mark of the ‘alive’, and thus should, more positively, be accepted as a ‘biological fact of life’, and (*ii*) to the existence of a certain empirical consistency between the contentious non-thermal effects and the types of adverse health effects (mainly neurological) reported by some people when exposed to *GSM* radiation, as well as that (the indication of an increased incidence of brain cancer amongst mobile phone users) found epidemiological – a consistency that further enhances the credibility of the non-thermal effects, and one that will hopefully motivate further research (from the necessary non-linear standpoint, of course) towards establishing their causal connections with presenting pathologies.

In conclusion, and in accord with philosophy espoused by the World Health Organisation, it can hardly be disputed that to enjoy an acceptable quality of life requires more than simply an absence of terminal disease. In this respect, even adverse health effects *of a non-life threatening kind* that might be provoked by exposure to *GSM* radiation must be considered unacceptable, in that they undoubtedly have a debilitating effect that undoubtedly undermines the general well-being of those affected, and which in the case of certain pre-adolescent children could well undermine their scholastic and neurological development.

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85. Although the energy of a *GSM* microwave quantum is insufficient to break molecular bonds (*i.e.* the radiation is non-ionising), it is possible that it (*i*) initiates subtle conformational changes, resulting in certain undesirable biochemical consequences, (*ii*) interferes with the natural process of DNA repair, resulting in a higher degree of fragmentation than would otherwise obtain.
86. 'Mobile Phones and Health', Report of the Independent Expert Group on Mobile Phones, May, 2000.
87. Gandhi O.P. *et al.* *Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900MHz*. IEEE Trans. MTT 1996; **44**: 1884-1897.
88. A similar non-uniqueness, it should be noted, also characterises the biological consequences of microwave heating, where, for example, a temperature rise of 1°C can be either lethal or life-saving depending on the condition of the person at the time. Thus whilst there is a uniquely predictable *physical* consequence of exposure to microwave radiation of a sufficient intensity – namely an increase in body temperature – the *biological* consequence of a given temperature rise *cannot* be uniquely predicted, since this depends on the physiological condition of the exposed, which *varies* from person to person. To cover a reasonable range of conditions, a certain safety margin is incorporated into the permitted microwave exposure intensity; indeed, it is a lack of consensus as to what the *magnitude* of this margin should actually be that is partly responsible for the variation in the exposure intensities recommended by different regulatory bodies.  
  
It is to be stressed, however, that the heating itself *always* occurs, *irrespective* of the physiological condition of the person (even whether alive or dead!), quite unlike the situation with non-thermal effects. It is, of course, this fact that underlies the possibility of using 'phantom' heads to determine *SAR* values; it should, however, be realised that the reliability of the values so obtained is contingent on the extent to which the dielectric properties of the synthetic brain fluids used actually approximate to those in the *alive* human brain. On the basis of what little information is available, the differences could prove to be significant.
89. New Scientist, *Editorial*, 4<sup>th</sup> November, 2000.
90. The carrier frequency is taken into account *only* in so far as it affects the absorbability of the radiation through size resonance.
91. Cherry, N. 'Criticism of the Proposal to adopt ICNIRP Guidelines for New Zealand', Lincoln University, N.Z., 1998.
92. A good example of such 'information' transfer is the ability of a light flashing at a certain rate (between 15 to 20Hz) to induce seizures in photosensitive epileptics. It is not so much a question of the amount of energy deposited by the light (which depends on its intensity) that provokes the seizure, but rather the fact that the flash frequency is 'recognised' by the brain because it is close to one characterising a particular brain activity – in this case, that associated with seizures.
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94. Hocking, B. *et al.* *Cancer incidence and mortality and proximity to TV towers*. Medical J. Australia 1996; **165**: 601-605.
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# Exposure to electromagnetic fields by using cellular telephones and its influence on the brain

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The widespread use of cellular telephones in recent years inevitably raises the question of the effects on brain function of the electromagnetic fields emitted by such telephones. A number of reports have now appeared indicating that the high-frequency electromagnetic fields emitted by cellular telephones do influence cognitive function and brain electrical activity. Two studies published this year in *NeuroReport* by Koivisto and colleagues showed that exposure to a 902 MHz electromagnetic field, typical of mobile telephones, decreased response times in simple reaction time and vigilance tasks and the time needed to perform a mental arithmetic task [1], as well as the response times on a working memory task [2]. Furthermore, the same group of investigators examined the effects of electromagnetic field exposure on electrical oscillatory activity in the human brain during an auditory memory task [3]. This study, which focused on event-related desynchronization and synchronization of the 4–6 Hz, 6–8 Hz, 8–10 Hz and 10–12 Hz narrow EEG frequency bands, found that exposure to the electromagnetic field increased EEG power in the 8–10 Hz frequency.

Other studies have also demonstrated effects on event-related brain activity [4,5] and cognitive function [6] as a result of the exposure of the brain to the electromagnetic field emitted by cellular telephones. In the present issue of *NeuroReport*, Huber *et al.* [7] report a study on the effects of exposure for 30 min to the electromagnetic field emitted by digital radiotelephone handsets on the EEG recorded during subsequent sleep. The electromagnetic field was directed either to the left or right hemisphere in order to simulate real life exposure conditions. Exposure to the electromagnetic field did not affect sleep stages or sleep latency, but it did enhance EEG power density in the 9.75–13.25 Hz range during the initial part of sleep. Interestingly, despite the fact that the exposure was unilateral there was no hemispheric asymmetry on the changes in

EEG power. These results show that even a short exposure to the electromagnetic fields emitted by cellular telephones can affect brain physiology.

The currently available literature suggests that some aspects of cognitive function and some direct measures of brain physiology may be affected by exposure to electromagnetic fields of the type emitted by cellular telephones. It has been suggested that the facilitatory effects on cognitive function may be the result of a slight increase in the temperature of the underlying brain tissue which might affect synaptic transmission [6], but the mechanisms remain unknown. It is too early to state whether there might be any long-term effects on human brain function. It is important to note that, in the study published in the current issue of *NeuroReport*, the changes in EEG power observed during the first 30 min of nonREM sleep were not observed at the end of the 3 h sleep episode. Similarly, the results of the studies that examined cognitive function do not allow conclusions about any long-term effects of cellular telephone use. Thus, it remains to be established whether repeated exposure to electromagnetic fields could have long-lasting effects on brain physiology and cognitive function.

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**This Opinion piece from Dr. Allen Frey hits all of the important points as to why researchers' reasoning has been faulty when their claim is no effects to humans from EMF exposures**

[http://www.the-scientist.com/yr2000/nov/opin\\_001127.html](http://www.the-scientist.com/yr2000/nov/opin_001127.html)

**The Scientist 14[23]:47, Nov. 27, 2000**

**OPINION**

**Cellular Phones: Are They Safe to Use?**

**By Allan H. Frey**

Resolving the question of whether cellular phones are safe has been complicated by conflicting information about electromagnetic fields (emfs): no danger; yes there is danger; well, we don't know. This has been unsettling for the public and has put pressure on health policy decision makers to act. But can they take action based on the biological data now available? I think not. In fact, I believe it would be unethical to use much of it to make public health decisions.

This area of research in the United States did not evolve as biological research normally does. It basically had its origin in the physics and engineering community's concern about the hazards of their high-power radio equipment in the late 1930s. This led to that community's initiation and substantial control of the funding for biological research and a persisting mind-set. The result has been biological research corrupted by conflicts of interest, research based on implicit assumptions that make little sense biologically, and research inappropriate because of erroneous notions. Even today, the physics and engineering community's mind-set, prominence as spokesmen, and influence over research funding decisions continue. As a consequence, we don't have a credible body of biological data involving electromagnetic fields on which to base public health decisions.

What must be done to provide the decision makers with a biological input? A sampling of documented events will indicate the answer. The key fact is that the mind-set of those who control the funding determines what is looked at and thus what is found. And this must change if we are to obtain the biological data necessary to decide if cellular phones, with the characteristics they have today, are safe to use.

**Conflicts of Interest**

In the 1980s, Nicholas Steneck, who at the time was director of the Collegiate Institute for Values and Science at the University of Michigan, received a major grant from the National Science Foundation's Program for Ethics and Values in Science and Technology. He and institute fellows in biology and physics used it to do an in-depth case study of this area of research; many of the conflicts of interest they uncovered were documented in two books.<sup>1</sup>

One example is that for many years a U.S. Air Force office has decided what research the Air Force will fund to determine if emf exposure is hazardous. This same office has been responsible for assuring residents that there is no evidence of hazard, when the Air Force wished to place radar (an emf source) in a residential area. Among Steneck's conclusions: "The establishment that controls RF (emf) bioeffects research has misled the public and researchers. ... Key decisions on such research have been influenced by persons with vested interests."

There are unjustified implicit assumptions underlying much of the research. One recent example is the multimillion dollar National Toxicology Program studies on carcinogenesis and promotion of 60-Hz magnetic fields of the National Institute of Environmental Health Sciences (NIEHS). It was assumed, for these studies and many others, that the relevant magnetic field parameter for inducing biological effects is a pure 60-Hz sine wave; and such was used in these studies. But the public is exposed to something very different, as the authors of the Toxicology Program studies admit 2: "While power line magnetic field exposures are predominantly sine-wave fields, residential and occupational exposures may include square waves, sawtooth waves, and other wave forms. Harmonics (120 Hz, 180 Hz, etc.) may also be found. Further, as appliances are switched on and off, spikes or transients in fields may occur.... This study used linearly polarized, pure sine-wave exposures at 60 Hz, with the fields turned on when the sine wave was at zero amplitude and gradually increased over seven to nine cycles (between 0.11 and 0.15 seconds) to full intensity, and similarly gradually decreased to avoid transients. The NIEHS studies evaluate the predominant component (60-Hz sine-wave magnetic fields) without all the complexities of the exposures that occur in residential and occupational settings." The authors make the implicit assumption that a pure 60-Hz sine wave is the relevant variable. In fact, there is reason to believe this is not true. Others have also concluded from their research that emf characteristics are critical as would be expected with biological organisms.<sup>3</sup>

Another implicit assumption is that a toxicology model (the higher the dose, the more the effect) should be used as a frame of reference in the selection, design and analyses of experiments. Thus experiments are funded to look for a dose-response relationship between electromagnetic field exposure and a biological variable. But is a toxicology model appropriate as a guide for biological research with electromagnetic fields? It's a crucial question, for our frame of reference determines what we look at and how we look; as a consequence, this determines what we find.

Electromagnetic fields are not a foreign substance, a toxin to living beings, like lead or cyanide. Rather, living beings are themselves electrochemical systems that use electromagnetic fields in everything from protein folding through cellular communication to nervous system function. Toxicology is the wrong model as has been detailed in depth.<sup>3</sup>

There are other implicit assumptions that have crippled research in this field. This area of biological research is encumbered, for example, with a vocal few who imagine that they are the possessors of "real truth." They like to talk about the dogma, the "laws of physics." If the data do not conform to the dogma, then the data must be wrong.

But one does not challenge data with the current dogma. That's upside down, it's the dogma that is tested by data obtained with constantly increasing precision of measurement and observation. This is the great leap in thinking that created science out of the thinking of the Medieval Age. It is to be expected that theories conceived at one level of observation will have to be modified as observational ability improves. But some scientists in this area implicitly assume that they have reached a "fundamental" level of understanding, which leaves no room for even more fundamental levels of understanding.

A brief illustration will make this point clear. In 1850, a trip from Washington, D.C., to Los Angeles would have taken more than six months in a wagon pulled by mules. Many times I have had breakfast in Washington and flown 2,500 miles to Los Angeles and arrived in time for lunch. If I went back in time to 1850 and stated the above, I'm sure there would be some physicists who would flatly say that the laws of physics show this is impossible--and then "prove" it with elegant calculations on the muscle energy output of mules and wagon axle

friction. They would have been right in their calculations but wrong in their implicit assumption that they knew everything that will ever be known. This kind of thinking has been frequent in this area of research, and it has crippled the research and resulted in misleading information in the literature.

### Inappropriate Research

One example is all that is needed to show why so much of the research has been fruitless. Twenty years ago, an epidemiological study indicated power lines may be associated with cancer genesis or promotion. Since then, numerous epidemiological studies with the apparent intent to prove or disprove that emfs cause or promote cancer have yielded conflicting results, yet more are under way.

This is a misuse of epidemiology. Epidemiological studies can't provide proof either way. Physicians do not have a full understanding of cancer genesis and promotion, and we lack emf measurements at individual residences in the years before the diagnosis of cancer. Thus we have critical unknowns. We don't even know what characteristics of the fields, those many years ago, were important and what should be measured. Clearly, endless epidemiological studies of unknowns cannot prove or disprove anything about emfs and cancer.

The foregoing is a tiny sample of the mind-set, conflicts of interest, implicit assumptions, and inappropriate research, all well documented, that derailed biological research needed to determine if emfs are a health hazard. As a consequence, policy makers don't have the biological data needed to determine if there is a hazard, and the public is confused. And a hundred million cellular phone users, who have not given informed consent, are unwitting guinea pigs in a grand biological experiment.<sup>4</sup>

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## CATANIA RESOLUTION

September 2002

The Scientists at the International Conference “State of the Research on Electromagnetic Fields – Scientific and Legal Issues”, organized by ISPEL\*, the University of Vienna, and the City of Catania, held in Catania (Italy) on September 13th – 14th, 2002, agree to the following:

1. Epidemiological and in vivo and in vitro experimental evidence demonstrates the existence for electromagnetic field (EMF) induced effects, some of which can be adverse to health.
2. We take exception to arguments suggesting that weak (low intensity) EMF cannot interact with tissue.
3. There are plausible mechanistic explanations for EMF-induced effects which occur below present ICNIRP and IEEE guidelines and exposure recommendations by the EU.
4. The weight of evidence calls for preventive strategies based on the precautionary principle. At times the precautionary principle may involve prudent avoidance and prudent use.
5. We are aware that there are gaps in knowledge on biological and physical effects, and health risks related to EMF, which require additional independent research.
6. The undersigned scientists agree to establish an international scientific commission to promote research for the protection of public health from EMF and to develop the scientific basis and strategies for assessment, prevention, management and communication of risk, based on the precautionary principle.

Fiorella Belpoggi, Fondazione Ramazzini, Italy

Carl F. Blackman, President of the Bioelectromagnetic Society (1990-1991), Raleigh, USA

Martin Blank, Department of Physiology, Columbia University, New York, USA

Emilio Del Giudice, INFN Milano, Italy

Livio Giuliani, University Camerino, Italy

Settimio Grimaldi, CNR-INMM, Roma, Italy

Lennart Hardell, Department of Oncology, University Hospital, Örebro, Sweden

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Wilhelm Mosgoeller, Institute for Cancer Research, University of Vienna, Austria

Elihu D. Richter, Unit of Occupational and Environmental Medicine, Hebrew-University-Hadassah,  
Jerusalem, Israel

Umberto Scapagnini, Neuropharmacology, University of Catania, Italy, Member of the European  
Parliament

Stanisław Szmigielski, Military Institute of Hygiene and Epidemiology, Warsaw, Poland

\* = Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro,  
Italy (National Institute for Prevention and Work Safety, Italy)